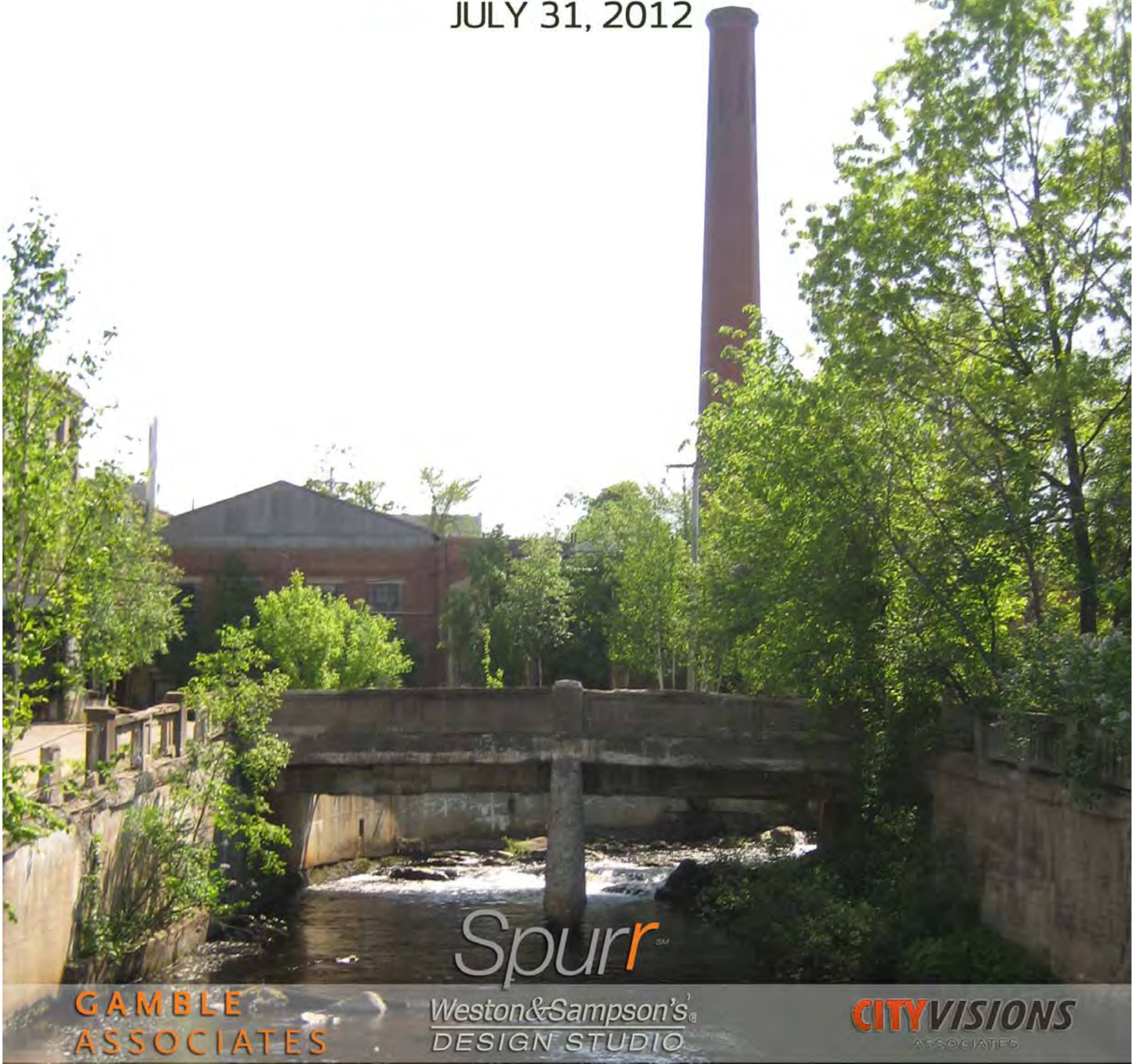
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

BROWNFIELDS AREA-WIDE PLANNING PILOT PROGRAM

REVITALIZATION OF THE SANFORD MILLYARD

ACTION PLAN

JULY 31, 2012



Revitalization of The Millyard Sanford, Maine

2012

This document is accompanied by The Millyard Handbook and a video summarizing the Town of Sanford's process of research, inventory, analysis, goals and objectives with actionable outcomes.

EPA Brownfields Area-Wide Planning Grant

EXECUTIVE SUMMARY

THE MILLYARD REVITALIZATION STRATEGY

Sanford must build upon its existing assets in the development of a brand that is focused on **specific market niches.** These niches need to benefit from the assets of the Town that are not currently identified with any other community in Maine.

Those niches are:
SUSTAINABILITY
HEALTH & WELLNESS
RECREATION

Sanford's market niche is to become a Center for Sustainability, Healthy Lifestyle and Outdoor Recreation. The Town already has a strong trail network and culture of water recreation. A new Riverwalk along the Mousam River will build on this system. Sustainability for Sanford's Millyard is defined as low-impact development strategies that maximize the site's renewable resources, leverage the existing infrastructure, and match tenants with what the Millyard has to offer to minimize need for extensive renovations.

The **incremental reuse** of the Millyard complex, and the creation of a new sustainable landscape around an engineered "Number Two Pond," will **connect the redevelopment of the Mills with the remediation of the land.**

Renewable energy technologies (solar, geothermal and microwind) will create lower energy costs and attract industries that would not otherwise come to the Millyard or Sanford. These technologies will combine to create a national model for power generation and environmental remediation.

INFORMATIVE ANALYSIS

Analysis undergone during the Area-Wide Planning Grant (AWPG) involved several key components, which were foremost in shaping the recommended revitalization strategy. This analysis included; existing conditions and infrastructure, market study, and community involvement activities.

Infrastructure and existing conditions analysis painted a picture of the physical state of the existing buildings and surrounding site of the mill yard, current structure of the buildings and sitewalls, necessary utilities that are present or lacking on the site, their current condition, and available capacities.

The market analysis carefully examined demographics, real estate demands, commercial and retail markets, commercial user base, comparable cities, public subsidy sources, and potential partnerships. The analysis illustrated the current population of Sanford and their needs, current market strengths and weakness and ways for Sanford to attract and benefit from the broader growing York County.

A large public outreach effort was undertaken to involve the community, community leaders, local business owners, local committees, and student participation. This effort proved that the Town of Sanford has a very eager community of people who want to be involved and are excited about the prospects of revitalizing the mill yard and learning the steps necessary to get there.

In depth information on these three key components can be found in the Section 1, Section 4, and Section 5 of this report.

The repositioning of the Millyard can be accomplished through six means of reinvestment**.**

1. **REHABILITATED INFRASTRUCTURE**
2. **ENVIRONMENTAL REMEDIATION**
3. **RENEWABLE ENERGY**
4. **ECONOMIC REDEVELOPMENT**
5. **ENGAGED COMMUNITY**
6. **IMPROVED HEALTH**

1. REHABILITATED INFRASTRUCTURE

DEVELOP A GAME CHANGER:

The most effective method of preventing suburban sprawl is through more intensive use of buildings and sites already in place. The mill buildings were built in the downtown core in close proximity to other establishments and near transit that minimizes transportation-related energy consumption. **Building on or near existing infrastructure allows local governments to avoid investment in costly, inefficient infrastructure extensions, which themselves can fuel more sprawl. It is expensive to extend public services to outlying areas**.

As part of the Area-Wide Plan, an audit of the existing infrastructure was made. The audit revealed that most of the site's utilities were of adequate or larger than adequate size and capacity for future development scenarios. However, the absence of natural gas has proven to be a deterrent for some prospective tenants and overhead electric wires may lack necessary power to service the desired mixed-use development strategies for the Millyard.

NATURAL GAS:

Extension of natural gas service into downtown and the Millyard area would mean reduced energy costs and provide the incentive for prospective tenants to relocate to Sanford and become a catalyst for the Millyard. Currently, natural gas lines are located approximately 4.2 miles away from the Millyard at the Sanford Airport. The most logical route to extend service between the airport and the Millyard is along Route 109/ Main Street. The Town, middle school, high school, and Goodall Hospital have all expressed interest in converting to natural gas as an energy source. The estimated $2 million in infrastructure costs are the key to making this critical connection. Early conversations with Unitil, the local utility company who owns and operates the natural gas system that runs to the Sanford Airport, have indicated that the utility is not in a position to fund the extension, but would collaborate with Sanford should funding become available.

2. ENVIRONMENTAL REMEDIATION

UNDERSTAND THE CHALLENGES TO CREATE SOLUTIONS:

The Sanford Millyard has obvious remnants of its industrial past. From the mill buildings themselves to old boiler plants and the lone remaining smoke stack. Less obvious are the contaminants that lurk within buildings and the landscape itself. Utilizing Environmental Protection Agency (EPA) Brownfield Assessment and Cleanup Grant funding as well as other sources, the Town of Sanford and their consultants performed a number of investigations of sites located throughout Sanford, however most of the efforts were focused on the Millyard Area. Specifically, the town conducted assessments, cleanups and engineering improvements at No.1 Pond, International Woolen Mills, Aerofab Mill, Sanford Mill, Map J29 Lot 17E, and multiple parcels located north of the main mill complex including the riverside area, the Stone parcel and new roadway parcels.

Services ranged from Phase I and II Environmental Site Assessments (ESAs) to building demolition and cleanup of impacted soil, pre-characterization prior to new roadway construction, engineering improvements and bank stabilization at No.1 Pond, as well as post remediation engineering including capping, structural evaluations and parking lot construction, and pre-characterization prior to construction of a new transportation hub for the Town of Sanford. In addition funds were used to develop a vision for the Millyard area. As part of the original assessment grant, the Town of Sanford developed a vision for a riverwalk. This vision was utilized to generate interest in this forgotten corner of the town.

The vision, combined with initial assessment on selected Millyard parcels leveraged future funding including the Revolving Loan Fund and the Cleanup grant for the Aerofab building. Additionally, the assessment and cleanup activities leveraged CDBG funding for the construction of a new road to provide access to the Millyard area. The construction of the new road has been critical in attracting developers to the Millyard complex and collectively, these efforts have paved the way for the area-wide planning grant, which has funded this comprehensive planning effort for the Millyard area.

Sanford's textile production required a wide variety of chemical components that ranged from petroleum to solvents. Today's stormwater impacts continue the process of accretion of contaminants from roadway run-off. **The site's past and present must be managed in order to mitigate the effects that these chemical compounds had and will continue to have on soil and groundwater**. Further, there is evidence of groundwater impact from upgradient off-site sources at some of the Millyard properties.

REMEDIATION OPTIONS:

The remediation strategy for the Millyard is to systematically contain, treat, or remove contaminants within each parcel to prepare them for renovation and redevelopment. Through community engagement, it was clear that public opinion is strongly in favor of a comprehensive cleanup that may include a variety of remediation technologies**. A collaborative approach will be needed to work with various property owners in the Millyard, while furthering environmental cleanup and redevelopment activities on the various parcels**.

While the Town has been successful in securing both assessment and cleanup money for many of their brownfields, there is still work to be done throughout the Millyard.

In May 2012 Sanford was awarded an additional $800,000 in EPA Brownfields funding. $400k has been earmarked for assessment and the other $400k divided into two grants; one for hazardous cleanup at the CGA site on New Dam Road and the other for petroleum-related cleanup at a parcel in the Millyard envisioned as a parking facility and as an access point to the Mousam River. The Assessment Grant will allow the Town of Sanford to leverage this infusion of capital to bring various and disparate mill building owners to the table to develop a strategic plan to tackle continued remediation needs within the Millyard.

3. RENEWABLE ENERGY

HARNESS THE SITE'S LATENT ENERGIES:

The Sanford Millyard and the land adjacent to the Mousam River offer exciting opportunities to harness, capture, and store the site's natural energies. Renewable energy technologies of today include wind, solar, geothermal, bio-energy, hydropower, tidal/wave or ocean, and hydro power. For the purposes of the Millyard, **geothermal and solar power** offer the most potential to decrease reliance on traditional fossil fuel sources and to assist in rebranding the site from a contaminated place to a sustainable destination.

GEOTHERMAL:

A Geothermal Heat Pump (GHP) system is a heating and cooling system that takes advantage of **heat stored in the ground**. The system uses the stability of underground temperatures to extract heat in the winter to warm spaces and cool building temperatures in the summer. A GHP system does not have aesthetic impacts. The infrastructure is below-grade and can be integrated with the landscape architecture of the site with minimal modifications. There are **no adverse environmental impacts** in a properly designed and installed GHP system. However the investment for installation costs of the infrastructure is substantial. Depending on the size of the system and number of buildings served, the payback period could range anywhere from 7 to 25 years. Geothermal energy systems have been successfully incorporated into recent construction projects elsewhere in Sanford in recent years.

SOLAR:

Solar photovoltaic (PV) systems require unshaded or **open areas on roofs or on the ground**, preferably with southern exposure. Solar resources for Sanford are moderate, although most mill buildings have large, flat, south-facing rooftop surfaces, which lend themselves well to solar arrays. There are also large areas on the ground adjacent to the Millyard where a solar array could be installed. While historically ground-mounted PV arrays have been fenced and preclude public access, new developments in solar panel mounting technologies allow for the public occupation of the open space beneath the panels. The payback period of a solar application ranges from 16-26 years.

WIND:

There are a number of scales at which wind energy is currently being developed. The Millyard's proximity to the downtown and water resources coupled with our initial analysis of wind exposure in the Millyard indicate that smaller microwind turbines may offer a tolerable payback period, but that large turbines are not feasible nor advisable at this site.

4. ECONOMIC DEVELOPMENT

NEIGHBORHOOD STABILIZATION:

The reuse of the Millyard buildings will have significant and ongoing economic impact beyond the historic buildings themselves. The buildings and the legacy they represent can be the foundation for new economic development. A commitment to reinvesting in the Millyard is also a commitment to the downtown, particularly the older residential neighborhoods nearby, the Midtown Mall and Main Street. By focusing attention and policies to the Millyard, Sanford is directing resources to the area that needs them most thereby creating a catalyst that will create a ripple effect of pride of place that will lead to improvement and ultimately private investment.

INCREMENTAL GROWTH:

The rehabilitation and reuse of the Millyard will take a generation or more to become a destination in and of itself. One must look beyond traditional market analyses and seek out **a mix of place-specific, non-traditional uses** that can create vitality and reposition a property or district as an interesting destination. Over time, these initial uses can **build value and generate a more positive image** for the area that leads to new interest in the remaining unoccupied space.

Some of these unique uses may include tenants like **Eastern Mountain Sports**, a company whose goal is to help people experience all aspects of outdoor recreation. They often hold outdoor demonstration expos where individuals can try outdoor gear like kayaks, bicycles, hiking boots, running shoes, mountain climbing, and camping gear. The Millyard offers a compelling setting for a regional retail location as well as a place for these outdoor demonstration events.

Another potential business fit comes from the indoor agriculture industry. These businesses, whether they grow tomatoes like Backyard Farms in Madison, Maine or mushrooms like Farming Fungii LLC, also of Maine, have a need for large open floor plates, access to sufficient clean water, and inexpensive power. The Millyard buildings also offer loading docks and direct access to air distribution through the Sanford Airport.

Industrial education and vocational training also offer a strong fit for use of the existing mill building infrastructure. The Sanford Regional Technical Center offers programs in automotive, building trades, computer-aided design and drafting (CADD), culinary arts, environmental science, health occupations, precision manufacturing and welding among others. These programs provide hands-on job training for students and prepare them for careers in professional trades. The Millyard offers a potential venue for some of these programs to expand based on the continued demand for skilled workforce labor.

The Nellie Mae Education Foundation (NMEF), the largest charitable organization in New England focused exclusively on education, has awarded a $3.7 Million grant distributed over three years to support student-centered approaches to learning among in Sanford, Maine. The grant will support the ongoing efforts of the Sanford School System to implement long-term plans to reshape their systems to help all students succeed at a higher level in an increasingly changing world. Part of these grant monies will be allocated to re-branding Sanford's educational system and communicating the profound work being done throughout the district. It is possible that expanding technical support facilities to the Millyard can help boost an already rising star in the Sanford School System.

TRANSIT:

The construction of the Federal Transit Authority (FTA)-funded Sanford Transit Center (STC) is an added benefit for the Millyard's redevelopment. It will enable more people to access the area and create a multi-modal destination for pedestrians, bikes, and buses. **The proximity of the STC in downtown and adjacency to the Mill complex will allow for greater connectivity**.

5. ENGAGED COMMUNITY

COMMUNITY ASPIRATIONS:

The Millyard is central to Sanford's sense of place. The Mill buildings are the most prominent feature of the landscape, with the striking pillar of the brick smoke stack visible to all who enter the town**. Identifying opportunities to reoccupy even a portion of the complex will improve the region's self-esteem and people's attitudes toward old industrial buildings**.

PARTNERSHIPS:

Preserving the buildings presents a significant challenge; their massive scale and unmaintained condition make for a complex task. However, saving an endangered industrial heritage will be made easier by **engaging strong partners**. Broad, sustained efforts, combined with creativity will help move the mill buildings off of the endangered list and on to **new roles in which they serve the community** in productive ways. Higher education institutions and healthcare establishments are well-positioned for mutually beneficial relationships with the Town of Sanford and the repositioning of the Millyard.

Throughout the community engagement process, the Sanford Regional Technical Center has been an active partner. Students initiated an effort to measure, draft, and create a scale model of portions of the Millyard to assist in the visualization of alternative futures for development. Previously students from this program had measured, drafted, digitally modeled, and recreated the historic concrete balustrade found along the Mousam River within the Millyard. Most recently, the high school and Technical Center also facilitated student engagement in two design workshop events held in the Middle School library.

COMMUNITY REVITALIZATION:

Historic preservation is an effective down-town economic development strategy. More than ever, cultural and natural assets form the basis for economic development in small communities. The greatest attractions for economic growth in many towns are the **quality of life, natural environment, historic legacy, and cultural context**. **Preserving the character of the Millyard is vital to Sanford's economic competitive edge over other towns in the region and northeast United States**.

6. IMPROVED HEALTH

HEALTH AND WELLNESS:

The design of the physical environment has a crucial and positive influence on improving public health. **The redevelopment of the Sanford Millyard and surrounding open space network will**

create new opportunities for daily physical activity and represents a promising strategy for pursuing environmental change in Sanford's downtown.

THE LANDSCAPE:

The Millyard is well positioned to advance health and wellness in the region in the following ways:

1. Through the **remediation of Brownfield Sites** into active and passive parkland.
2. Through an engineered riverbed that creates "**Number Two Pond**" with opportunities for water-based, year-round recreation from kayaking to ice skating.
3. Through the development of an inviting and accessible **Riverwalk** that connects to the broader **trail network** as a hub destination for hiking and biking.
4. By providing a **unique outdoor environment** that supports civic events and becomes a draw for visitors and tenants of the Millyard alike.
5. By **attracting tenants** who are associated with health and wellness and would benefit from the association.

The design of the trail network will promote physical activity and increase community awareness of the benefits of active living. The Riverwalk and Number Two Pond will increase opportunities for physical activity by extending the existing trail system that **enhances linkages with adjacent neighborhoods** and creates a culture where walking and biking are preferred over driving. Regional events like triathlons and road races perpetuate fitness and healthy living as an inherent part of living in Sanford. A more robust open space network can also influence the policies and partnerships that support active living in Sanford and York County.

GOODALL PARTNERSHIP:

A potential partner in this theme for the revitalization and health of the Millyard is Goodall Hospital. As the town's largest employer, there are partnering opportunities to collaborate with the region's primary health care facility. The hospital is less than a mile from the Millyard. Focusing on health, wellness, and recreation align with the hospital's core mission.

MILLYARD REPOSITIONING NEXT STEPS

1. <u>NATURAL GAS EXTENSION</u>
2. <u>EXPLORE FEDERAL FUNDING FOR TRANSPORTATION IMPROVEMENTS TO PEDESTRIAN CONNECTIONS, MAJOR DOWNTOWN INTERSECTIONS, AND STRUCTURED PARKING</u>
3. <u>RENEWABLE ENERGY FEASIBILITY DESIGN</u>

4. ENGINEERING OF NUMBER ONE POND AND MOUSAM RIVER FOR WATER RETENTION DESIGN AND INFRASTRUCTURE IMPROVEMENT / TECHNICAL ANALYSES
5. EXPLORE FUNDING FOR CONTINUED BROWNFIELDS ASSESSMENT AND CLEAN UP, USE FUNDING TO LEVERAGE PROPERTY OWNERSHIP FOR KEY MILL BUILDING REPOSITIONING.

Revitalization of The Millyard Sanford, Maine

EPA Brownfields Area-Wide Planning Grant

ACTION PLAN 2012-2014	**2012**		**2013**				**2014**				**Est. Cost**
7/16/2012	3	4	1	2	3	4	1	2	3	4	in thousands
LANDOWNER CONSENSUS											
Strategize about what assets the Town can leverage for landowner cooperation	X	X									internal
Coordinate a meeting with the landowners			X	X							internal
Town acquisition of properties for Transit Center and associated Phase 1			X								
MILLYARD CALL TO ACTION KICK-OFF EVENT	X										
Sanford Regional Economic Growth Council to lead a rallying event											$5-$10
ENGAGED COMMUNITY											
Public screening of The Millyard video by Beatnik productions (in Millyard)	X										$5
Create a Town Bicycle/Pedestrian Advisory Board	X	X	X								internal
Develop partnerships for new programs and events to promote active living	X	X	X	X	X	X	X	X	X	X	internal
REHABILITATED INFRASTRUCTURE											
Explore viability of extension of natural gas service into the Millyard area	X	X	X	X	X	X	X	X	X	X	$2,000
Coordinate with Central Maine Power for overhead utility line relocation	X	X	X	X							$500
Advance site planning and schematic design of the Mousam Riverwalk	X	X	X	X	X	X	X	X			$150
ENVIRONMENTAL REMEDIATION											
Determine ownership of Mousam River and engage regulators		X	X								internal
Collaborate with Patricia Aho, Deputy Secretary of DEP on regulatory obstacles			X	X	X	X					$50
Conduct necessary technical analysis for the creation of Number Two Pond	X	X	X	X	X	X					$50
Advance hazardous clean-up assessments for IWC Boiler Building	X	X	X	X	X	X	X	X			$400
RENEWABLE ENERGY											
Detailed geotechnical/geological study of subsurface for geothermal system	X	X	X	X							$25
Design site layout for solar PV project, system size, electrical improvements, structural checks and secure the necessary permits	X	X	X	X	X	X	X	X			$120
Obtain Green Infrastructure Grant from EPA		X									$40,000
ECONOMIC DEVELOPMENT											
Detailed redevelopment analysis: phasing, initial targeted property redevelopment, tenancy, tax credit analysis	X	X	X	X							$100
Acquire FTA Funded Transit Center Grant	X										$1.3 mil
IMPROVED HEALTH											
Initiate first annual Millyard Health Fair + Triathlon Event	X	X	X	X							
Explore incentives for fresh food financing initiatives	X	X	X	X	X	X					
Implement changes to the physical (multi-modal) transportation environment	X	X	X	X	X	X	X	X	X	X	

SECTION 1

ENVIRONMENTAL REMEDIATION

1. REHABILITATED INFRASTRUCTURE

DEVELOP A GAME CHANGER:

The most effective method of preventing suburban sprawl is through more intensive use of buildings and sites already in place. The mill buildings were built in the downtown core in close proximity to other establishments and near transit that minimizes transportation-related energy consumption. **Building on or near existing infrastructure allows local governments to avoid investment in costly, inefficient infrastructure extensions, which themselves can fuel more sprawl. It is expensive to extend public services to outlying areas**.

As part of the Area-Wide Plan, an audit of the existing infrastructure was made. The audit revealed that most of the site's utilities were of adequate or larger than adequate size and capacity for future development scenarios. However, the absence of natural gas has proven to be a deterrent for some prospective tenants and overhead electric wires may lack necessary power to service the desired mixed-use development strategies for the Millyard.

NATURAL GAS:

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Sanford Brownfields Summary

Property Name	Property ID	Current Land Use	Environmental Investigations	MEDEP Regulatory Status	Findings
Millyard Area					
Reeves-Map J29 Lot 17E	Reeves-Map J29 Lot 17E	Vacant	Phase I and II ESA	Not listed	Potential impacts from offsite sources, stormwater runoff, petroleum and chlorinated solvents
Reeves-Map J29 Lot 17E	Reeves-Map J29 Lot 17E	Vacant	Phase I and II ESA	VRAP	Petroleum and chlorinated solvents impacts to soil and groundwater from off and on-site sources, metals (hex-chromium) impact to groundwater from on-site source
Reeves-Riverwalk-2	Reeves-Riverwalk-2	Vacant	Phase I and II ESA	Not listed	Potential impacts to soil from potential upgradient offsite sources, chlorinated solvent impacts to groundwater from potential upgradeint off-site sources
Rierwalk-4	37, 39 and 41 High Street	Resdential Housing	Phase I ESA	Not listed	REC: Upriver historic mill use. No further investigation conducted.
Rierwalk-5	0 Bougie Lane	Vacant	Phase I ESA	Not listed	RECs: Historical buildings & use of the Site for activities associated with lumber work; upriver historic mill use. No further investigation conducted.
Riverwalk-7/ Riverwalk-7A	0 Emery Street	Vacant	Phase I ESA	Not listed	RECs: Historical buildings & use of the Site for activities associated with lumber work; upriver historic mill use; Reported Phase II investgation & remediaotn on-site; Potential impact from off-site sources. No further investigation conducted.
Stone & Stone	72 Emery Street		Phase I and II ESA	VRAP	Petroluem (diesel range organics) , SVOC contamination to soil and groundwater. Onsite sources.
Outside Millyard Area					
Gallo Property	102 Cottage Street	Restaurant	Phase I ESA	Not listed	RECs: current/historical USTs onsite; reported gasoline & oil release from onsite UST/AST; historical Site use as xervice station/tire shop/fuel oil co.; historical use of abutting property as aut repair shop. No further investigation conducted.
#1 Pond	#1 Pond	pond/public park/wildlife refuge	Phase I ESA	Not listed	Possible presence of hazardous substances and/or petroleum products. Phase II ESA was not conducted.

Notes:
MEDEP = Maine Department of Environmental Protection
Phase I ESA = Phase I Environmental Assessment
Phase II ESA = Phase I Environmental Assessment
VRAP = Voluntary Response Action Program
REC= Recognized Environmental Condition
SVOCs = semi-volatile organics
UST = Underground Storage Tank
AST = Abovegroun Storage Tank

RW - Riverwalk Property

FIGURE 2
AERIAL VICINITY PLAN
RIVERWALK PROPERTIES

Town of Sanford
Sanford, Maine

SOURCE: MEGIS Index Photo - 1f_355_9481 Dated: May 2003

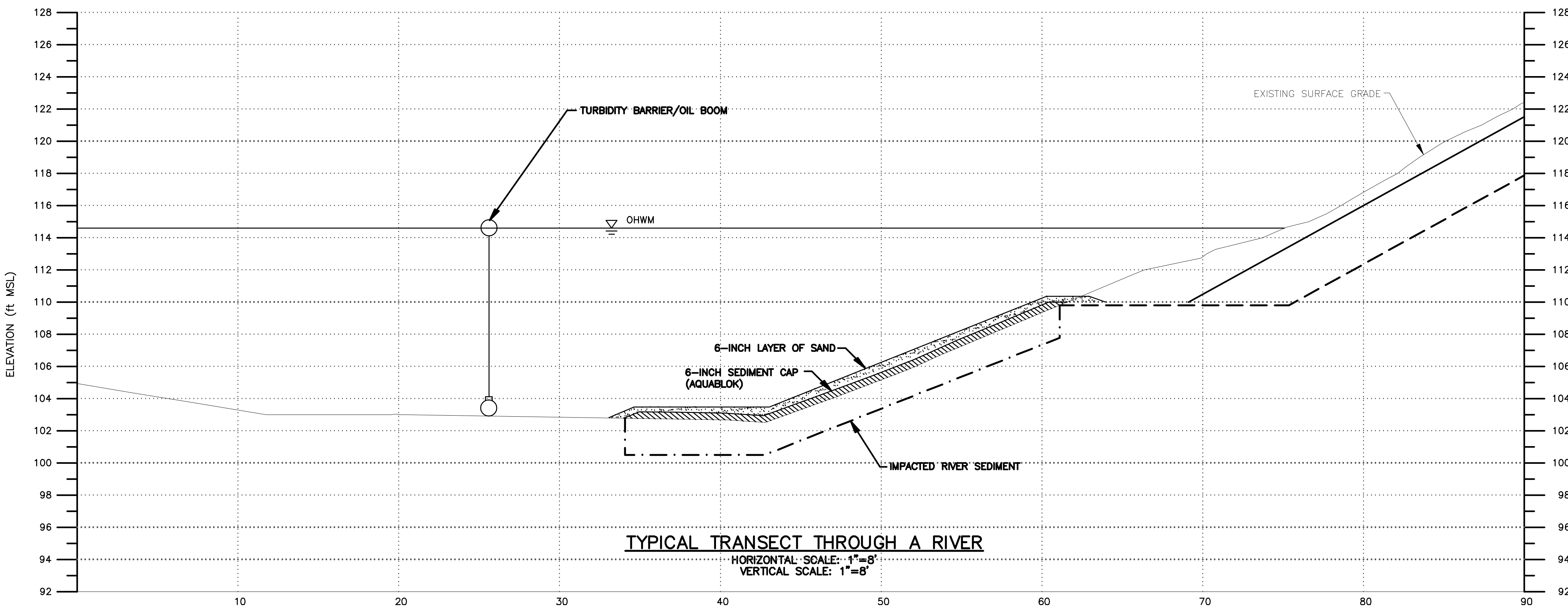
SCALE: 1" = 300' (approx) | DATE: 11/7/06 | DWG: A-248-6610

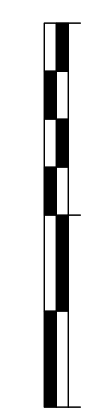
MAI ENVIRONMENTAL
Compliance ▾ Hydrology ▾ Engineering ▾ Permitting
1034 BROADWAY ▾ SOUTH PORTLAND, ME 04106 ▾ PHONE: (207) 767-3663

In-place River Sediment Capping Detail Example

Illustrative section and “AquaBlok” product information

Weston & Sampson





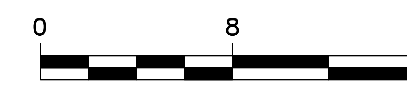


FIGURE 1

TYPICAL TRANSECT SCHEMATIC

RIVER SEDIMENT CAP DETAIL

DESIGNED BY: MER	CHECKED BY: BJM	DATE: DECEMBER 2011

Weston&Sampson®

O:\DCAM\Medfield Hospital\CADD\C&D Area Design\100% Plans\Sediment Cap Detail.dwg

AquaBlok®
Composite Particle System

PRESS RELEASE

Media Contact: John Collins, General Manager (+01) 419.385.2980

PONDSEAL™ Proves Effectiveness in Stopping Leaks in Ponds / Canals / Levees / Reservoirs / Dams

TOLEDO, OHIO, April 20, 2009 – **AquaBlok, Ltd.,** a manufacturer of innovative clay-based composite materials, is pleased to announce multiple successful applications of its sealant products that benefit from the company's patented system for delivery of sodium bentonite in, around, and through the water. While the material has been manufactured and sold for other uses since the mid-1990s, the PONDSEAL name was introduced in the fall of 2007 with the specific intent of addressing unwanted seeps and leaks in inland waterways.

AquaBlok® PONDSEAL products are superior to bentonite alone due to the reliable, targeted placement and self-compacting nature of their coated stone core design. In its most basic application, PONDSEAL can readily descend through the water, hydrate, swell, and coalesce to form a flexible but cohesive layer or liner on the bottom of a pond, reservoir, canal, levee, or dam to block off potential leakage pathways.

Additional application techniques continue to be developed. "What's perhaps most exciting about PONDSEAL is its versatility in the field," says AquaBlok Sales Manager, Eric Kraus. "As we have introduced the product and its attributes to more professionals in the lake and pond management and construction industries, we are finding an increasing number of applications where our particle composition has time- and cost-saving advantages over conventional practices and remedies."

Figure 1. Compromised (leaking) pond basin.

Figure 2. Pond basin following PONDSEAL repair.

Problem Statement: Many waterways – including ponds, canals, levees, lakes and reservoirs – suffer from a range of conditions that cause ongoing leaks. Examples include: porous or permeable soils; compromised soil liners; faulty control structures (e.g. pipes, spillways, dams, etc.); the presence of remnant field drainage tiles; animal damage; and a variety of other natural or construction-related issues. Once a leak is identified, few options exist to create an effective seal without first draining the water from the basin. Particularly in more mature waterways, this is often undesirable due both to cost and to the significant disruptive impact such a disturbance has on life in the system. Additionally, in holding/settling ponds or other similar settings, a disruption of operations can also occur if the basin needs to be drained for repair.

Advantages of PONDSEAL: Although pure bentonite powder and granules (or "chips") are often promoted as a remedy (by simply pouring raw material through the water), most practitioners in the field understand that this method is generally ineffective since only a fraction of the material applied actually makes it to the target area. Additionally, even when raw bentonite does make its way to the desired location, it is not adequately compacted to produce a reliable and effective seepage barrier.

By contrast, the dense aggregate (stone) core of each PONDSEAL particle provides the mass to effectively deliver the bentonite though the water to the bottom, where all of the sealant material can be effectively utilized. PONDSEAL will not drift or dissipate, and unlike clays in their raw form, the composite particle is easy to handle and apply (no tilling, blending, or compacting equipment needed). The aggregate within the material provides "self-compaction" (resistance for the hydrating and expanding bentonite), creating a more stable layer that will remain in place over time.

Other important features of AquaBlok PONDSEAL include:

- Can be installed in stages – simply re-apply if additional leaks are discovered at a future point
- Forgiving – will re-hydrate after drying an infinite number of times if water levels expose the material; readily "re-heals" if punctured or cut
- Pliable and durable when hydrated – creates an extremely low permeable layer that will weather natural variations and will not "liquefy" during seismic events


Figure 3. Remnant field tile repair using PONDSEAL (following drawdown from active leak).

Available Products and Pricing: PONDSEAL is currently available both in 50-lb. paper bags and in ~2,400-lb. capacity FIBC bulk bags (for larger applications).


Figure 4: PONDSEAL packaging options – 50-lb. bags (left), 2,500-lb. bulk bags (right).

Pricing is comparable to equivalent bentonite alternatives. Specific pricing is available upon request and is dependent on quantity purchased. Contact AquaBlok for more information.

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search... Search

Sediment Remediation

- Overview
- General Description
- Intergration with Other Remedial Approaches
- Ecosystem Applicability
- Methods of Material Packaging, Handling, and Placement
- Interim Capping as a Sediment Management Alternative
- Cost
- Laboratory Testing
- Installation and Support
- Installation Profiles
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Sediment Remediation

Installation Profiles

Site Location:	Eagle River Flats Superfund Site in Fort Richardson, Alaska [US EPA Region 10]
Project Status:	Completed in 1994
Setting/Purpose:	Wetland (freshwater, with periodic brackish tidal inundation). Encapsulation of contaminated sediments.
Contaminant(s) of Concern:	White Phosphorous (WP)
Cap Design/Site Area:	Placed at hydrated thicknesses ranging from approximately 2.4 inches (~6 cm) on level ground to approximately 6.3 inches (~16 cm) in "cratered" areas of the project site. Approximately 4,000 square meters (43,000 square feet).
Method of Placement:	Helicopter with specially designed material drop bags.

Note: Not actual photo of Eagle River Flats (ERF) demonstration. Blackhawk helicopter with same bags used at ERF.

Site Location:	Grasse River, Massena, New York [US EPA Region 2]
Project Status:	Pilot completed in September 2001.
Environmental Setting:	River (freshwater)
Intended Purpose for AquaBlok Use:	Encapsulation of contaminated sediments
Contaminant(s) of Concern:	PCBs (polychlorinated biphenyls)

Cap Design/Site Area: Multi-layer design. Design comprised of a basal layer of hydrated AquaBlok (~3-4 inches or ~8-10 cm in target thickness) covered by a surficial layer of sand/topsoil mix (~6 inches or ~15 cm in target thickness). Site area was 2,760 square meters (29,700 square feet).

Method of Placement: Barge-based crane plus clamshell.

AquaBlok, Ltd. manufactures and distributes AquaBlok® products for all applications. Adventus Americas, Inc. provides consultation for special blends of AquaBlok® reactive sediment caps and applications of standard AquaBlok® for environmental remediation projects, and is a distributor of AquaBlok® products for environmental remediation projects.

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Site Location: Ottawa River in Toledo, Ohio [US EPA Region 5(1)]

Project Status: Completed in September 1999

Setting/Purpose: River (freshwater) with estuary characteristics. Encapsulation of contaminated sediments.

Contaminant(s) of Concern: PCBs (polychlorinated biphenyls), various metals

Cap Design/Site Area: Three different cap designs of approximately equal area and occurring within three different sections of the site (Section A, Section B, and Section C):

- Section A cap: Design comprised of a layer of hydrated AquaBlok (~5-6 inches or ~13-15 cm in target thickness).
- Section B cap: Design comprised of a basal geogrid component (Tensar) covered by a layer of hydrated AquaBlok (~5-6 inches or ~13-15 cm in target thickness).
- Section C cap: Design comprised of a basal geogrid component (Tensar) covered by a layer of hydrated AquaBlok (~5-6 inches or ~13-15 cm in target thickness) covered by a surficial layer of stone-armor material (~2 inches or ~5 cm in target thickness).
- The site area was 9,950 square meters (107,000 square feet).

Method of Placement: Various methods demonstrated, including: telescoping - articulating conveyor (barge- and shore-based), crane plus clamshell (shore-based), helicopter with specially designed material drop bags.

Site Location: Upper Outfall in Macon, Georgia [US EPA Region 4]

Project Status: October 2001

Setting/Purpose: River (freshwater). Encapsulation of contaminated sediments.

Contaminant(s) of Concern: PAHs (polynuclear aromatic hydrocarbons).

Cap Design/Site Area: Multi-layer design comprised of a basal layer of hydrated layer (~6-7 inches or ~15-18 cm in target thickness) covered by a layer of sand (~4-6 inches or ~10-15 cm in target thickness) covered by a surficial layer of riprap stone (~36 inches or ~91 cm in target thickness). Site area was 150 square meters (1,600 square feet).

Method of Placement: Shore-based excavator.

Site Location: Deer Creek Superfund Project in St. Louis, Missouri [US EPA Region 4]

Project Status: Completed February 2002

Setting/Purpose: River (freshwater). Encapsulation of contaminated sediments, within the context of a bank stabilization project.

Contaminant(s) of Concern: Hydrocarbon/petroleum-based (creosote) from an industrial process plant.

Cap Design/Site Area: Multi-component design:

- River-channel area: Layer of hydrated AquaBlok (~6 inches or ~15 cm in target thickness) covered by a non-woven geotextile covered by a surficial layer of aggregate and riprap stone (~26 inches or ~66 cm in target thickness).
- Bank-slope area: Layer of hydrated AquaBlok (~6 inches or ~15 cm in target thickness) placed in Geoweb cells covered by a non-woven geotextile covered by a surficial layer of aggregate and riprap stone (~26 inches or ~66 cm in target thickness).
- Site was 510 square meters (5,500 square feet).

Method of Placement: Material typically placed directly from SuperSacks suspended from a shore-based excavator.

Site Location:	Fraser River in Burnaby, British Columbia [British Columbia (Canada)]
Project Status:	Completed Summer 2003
Setting/Purpose:	River (freshwater) - Encapsulation of contaminated sediments, within the context of a wetland restoration project
Contaminant(s) of Concern:	Organic (creosote-related) contaminants
Cap Design/Site Area:	Multi-layer design. Design comprised of a layer of hydrated AquaBlok (~12-15 inches or ~31 to 38 cm in target thickness) covering a sand/gravel bedding layer and covered by a sand/gravel layer (~12 inches or ~31 cm in target thickness) covered by a marsh topsoil (~24 inches or ~61 cm in target thickness). The AquaBlok material was also underlain by a 39 inch- or one meter-thick gas vent layer. Site area was 4,170 square meters (44,800 square feet).
Method of Placement:	Crane with concrete bucket.

Site Location:	Anacostia River in Washington, D.C. [US EPA Region 3]
Project Status:	Completed April 2004
Setting/Purpose:	River, tidally influenced (freshwater). EPA SITE Program (Superfund Innovative Technology Evaluation). Demonstrated encapsulation of contaminated sediments, within the context of an "active caps" designed to accomplish contaminant treatment concurrent with encapsulation
Contaminant(s) of Concern:	PAHs (polynuclear aromatic hydrocarbons); PCBs (polychlorinated biphenyls); and metals.
Cap Design/Site Area:	Multi-layer design. Design comprised of a basal layer of hydrated AquaBlok (~4 inches or ~10 cm in target thickness) covered by a surficial layer of sand (~8 inches or ~20 cm in target thickness). Site area was 745 square meters (8,000 square feet).
Method of Placement:	Barge-based crane plus clamshell.

Site Location:	Kearny Marsh in Kearny, New Jersey [US EPA Region 2]
Project Status:	Completed in August 2005
Setting/Purpose:	Freshwater marsh – Encapsulation of contaminated sediments.
Contaminant(s) of Concern:	PAHs (polynuclear aromatic hydrocarbons) and heavy metals.
Cap Design/Site Area:	Design variations comprised of a layer of hydrated AquaBlok (~6 inches or ~15 cm in target thickness), carbon-amended AquaBlok, and sand. Site area was comprised of six test plots of 3,600 SF each, for a total of 21,600 SF.
Method of Placement:	Land-based stone slinger.

Site Location:	Chattanooga Creek in Chattanooga Tennessee [US EPA Region 4]
Project Status:	Completed in November 2006
Setting/Purpose:	Freshwater creek and floodplain area. Seal/Liner construction to isolate mobile contaminants in surrounding area.
Contaminant(s) of Concern:	PAHs (polynuclear aromatic hydrocarbons).
Cap Design/Site Area:	Layer of 3070FW Blended Barrier product was applied in 8" thickness in prepared creek bed and hydrated. A 6" layer of native soil was applied over the cap. Site area was comprised of a 2,000-foot segment of the creek which included an oxbow, for a total of over 175,000 SF.
Method of Placement:	Land-based stone dump trucks and long-stick excavator.

AquaBlok®

Technology Overview

General Description

AquaBlok® is a patented, composite-aggregate technology resembling small stones and typically comprised of a dense aggregate core, clay or clay-sized materials, and polymers (Figure 1). For typical freshwater product formulations, AquaBlok's clay (sealant) component consists largely of Bentonite clay. However, other clay minerals or clay-sized materials can be incorporated to meet project-specific needs, including product use in saline environments. Other technology parameters (particle size, relative clay content, etc.) can also be modified as appropriate.

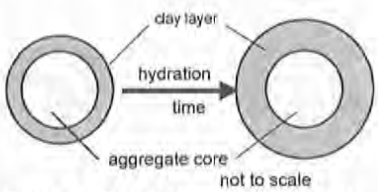


Figure 1. Configuration of Typical AquaBlok Particle.

General Functional Attributes

AquaBlok particles expand when hydrated, with the degree of net vertical expansion determined largely by the formulation, application thickness, and salinity of the hydrating water. When a mass of particles is hydrated, the mass transforms into a continuous and relatively soft body of material. Once developed, the hydrated AquaBlok material can act as an effective physical, hydraulic, and chemical environmental barrier by virtue of its relatively cohesive and homogeneous character, low permeability to water, and chemically active (sorptive) nature.

AquaBlok can also provide substrate for wetland vegetation and habitat for macroinvertebrate organisms, particularly when additional organic material is provided, either as part of the product formulation or as a surficial dressing. The AquaBlok technology can also deliver plant seeds to a targeted area to facilitate wetland restoration (see discussions related to the SubmerSeed® technology, as well as chemical reagents for *in situ* treatment of environmental contaminants.

Photograph 1. Product applied using barge-based conveyor.

Typical Applications

For many projects, AquaBlok use generally involves applying dry masses of the product through water and across the surface of contaminated sediments. In a matter of days, a homogeneous and relatively cohesive, low-permeability cap, or barrier, is formed between contaminated sediments and the overlying water column and its inhabitants. Barrier thickness will depend on a number of factors, including: type of formation, water depth and salinity, application thickness, number of lifts applied, and sediment characteristics.

AquaBlok can also be used as a hydraulic/chemical barrier to the movements of water- or sediment-borne contaminants into underlying groundwater resources, or to minimize leaching losses of water from reservoirs or wastewater discharge basins.

Integration with Other Remedial Approaches

Effective management of contaminated sediments may involve remedial capping exclusively or an integration of capping with other management technologies like dredging and/or monitored natural recovery. *In situ* capping may also be integrated with *in situ* sediment treatment technologies to affect mass reduction of encapsulated contaminants.

Ecosystem Applicability

AquaBlok can be applied to impacted wetland and deepwater aquatic ecosystems characterized by either freshwater or saline (including brackish) conditions.

Methods of Installation

AquaBlok can be handled and installed using commonly available equipment and technologies, including conveyors (e.g. Photograph 1), excavators, cranes with clamshell buckets, and even helicopters.

Other techniques could also be used to effectively install AquaBlok-based sediment caps. The most appropriate installation methods(s) will depend on a variety of factors including: water or shoreline access, bank slope, surface water characteristics and ecology, size of the project area, and relative costs.

Costs

Costs for implementing an AquaBlok-based capping remedy will vary widely depending on a number of project- and site-related factors that will collectively dictate the most appropriate AquaBlok formulation, cap design, and method for cap installation. Project costs will also depend on whether material is packaged and transported to the project site, or whether it is manufactured at or near the site. Costs associated with project planning and management; preliminary laboratory studies (if required); cap design; permitting; construction QC; long-term performance and monitoring; and cap maintenance should also be considered.

If you think the AquaBlok composite particle system could be of use in your remediation projects, call us. We will be happy to discuss your project with you, and help determine how the AquaBlok technology could integrate into a cost-effective solution.

AquaBlok®
Composite Particle System

For more information, including the complete test reports, call AquaBlok, Ltd. at (800) 688-2649 or fax us at (419) 385-2990.

The test reports are also available on our website at: www.aqublokinfo.com.

Last Revised 07/26/06

Dry State Physical Characteristics

AquaBlok™

TEST REPORT #1: Dry State Physical Characteristics of Typical Freshwater AquaBlok™ Formulations

Background and Purpose of Testing

The AquaBlok™ composite particle system typically includes a combination of clay minerals, polymers, and an aggregate core. As shown in Figure 1, each AquaBlok particle typically consists of a clay-based outer shell (sealant layer) that is fixed with polymers to a nucleus (aggregate core) comprised of stone or other hard material.

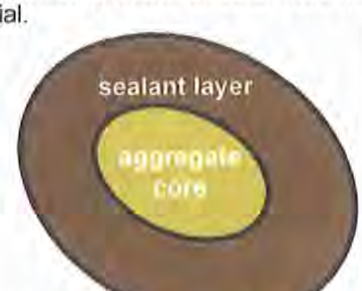


Figure 1. Configuration of Typical AquaBlok Particle.

AquaBlok's configuration facilitates efficient delivery of reactive clay components, like bentonite, through water to form a cohesive barrier between contaminated sediments and the overlying deepwater or wetland ecosystem. AquaBlok can be modified in terms of its physical or clay mineral characteristics to accommodate site-specific conditions or to meet overall project objectives. For example, bentonite-based formulations are typically used for freshwater applications, whereas blended or attapulgite-based formulations are typically used for most saline applications.

The purpose of this set of laboratory tests was to demonstrate general dry state physical characteristics of typical freshwater (bentonite-based) formulations of AquaBlok, both in terms of bulk (mixed) characteristics as well as characteristics associated with discrete particle size classes.

Methods

Large bulk samples of AquaBlok were prepared using well graded stone aggregate plus proprietary polymers and varying quantities (weight percentages) of bentonite clay material. Aggregate used to prepare product samples for most of the testing was nominally equivalent in size gradation to AASHTO No. 57 aggregate. Some of the tested product was also prepared using core material nominally equivalent in size gradation to AASHTO No. 8 aggregate, or using selected blends of aggregate.

The formulations prepared ranged from a relatively bentonite-rich product (70% bentonite plus 30% aggregate, referred to as 7030 FW) to a much leaner formulation (20% bentonite plus 80% aggregate, referred to as 2080 FW).

Selected dry state physical characteristics of AquaBlok were demonstrated using representative subsamples of the prepared formulations. Physical characteristics determined included: air-dry bulk density and per-cent inter-particle porosity; particle size distribution and composition; moisture content; and average particle density.

Dry bulk density was determined by weighing dry masses of AquaBlok of known volumes. Percent inter-particle porosity was estimated as the quantity ((mean particle density - mean bulk density)/mean particle density) x 100. Particle size distribution was determined in general conformance with ASTM Method D421; this involved passing split-and-quartered bulk sub-samples of a given formulation through a series of five metal sieves and measuring total particle mass retained on each sieve, as well as the finer material passing through the smallest (#10) sieve.

Particle composition was determined on oven-dry subsamples by physically removing clay coatings from aggregate and weighing respective clay and aggregate components.

Particle moisture content was determined in general conformance with ASTM Method D2216.

Average particle density was determined by first weighing subsamples of air-dry particles then determining the volume of water displaced by this mass of particles (to obtain sample volume).

Results

Testing results for selected formulations are presented in figures 2 through 6.

Observations and Conclusions

Air-dry bulk densities for different product formulations typically range from approximately 75 to 90 pounds per cubic foot (Figure 2). For a given aggregate type (e.g. No. 8), values tend to be higher when greater percentages of the formulation are comprised of aggregate. Bulk density values also vary with particle gradation, and to a lesser degree with moisture content.

Clay (bentonite)-rich formulations tend to be comprised of larger-diameter particles than are leaner product formulations, as illustrated by differences in the proportion of 1.00 – 0.75 inch-sized particles for the 7030 FW and 2080 FW formulations (Figure 3). This is an artifact of the manufacturing process.
(continued on back)

Figure 2. Typcial Ranges for Dry Bulk Density and Estimated Inter-particle Porosity for Selected Freshwater AquaBlok Formulations

Product Formulation	Aggregate Core	Estimated Inter-particle Porosity (percent)	Dry Bulk Density, Typical Range (lbs/ft³) 75 80 85 90 95
2080 FW	No. 8	35	
3070 FW	No. 8	45	
4060 FW	No. 8	36	
2080 FW	No. 57	37	
4060 FW	No. 57	35	
5050 FW	No. 57	40	
3070 FW	Nos. 8 + 57	36	
3070 FW	Nos. 57 + 4	35	
3070 FW	No. 4	42	

Smaller particles tend to carry relatively higher percentages of clay than larger particles, particularly for relatively clay-rich formulations (Figure 4). This is also an artifact of the manufacturing process.

Smaller particles tend to contain higher moisture content than larger particles (Figure 5). This is because moisture is primarily associated with the clay component and because smaller particle size fractions tend to have higher clay percentages than larger size fractions.

For any formulation, smaller particles tend to be somewhat less dense than larger particles (Figure 6). This is because of the presence of higher proportions of the relatively less dense clay. This apparent relationship between particle size and density is generally accentuated in bentonite-rich formulations in which relatively greater percentages of each particle size are comprised of clay rather than aggregate.

Figure 3. Particle Size Distribution (No. 57 aggregate core)

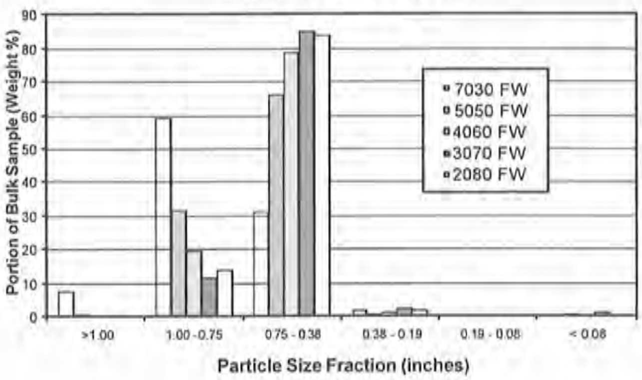


Figure 4. Relative Bentonite Content (No. 57 aggregate core)

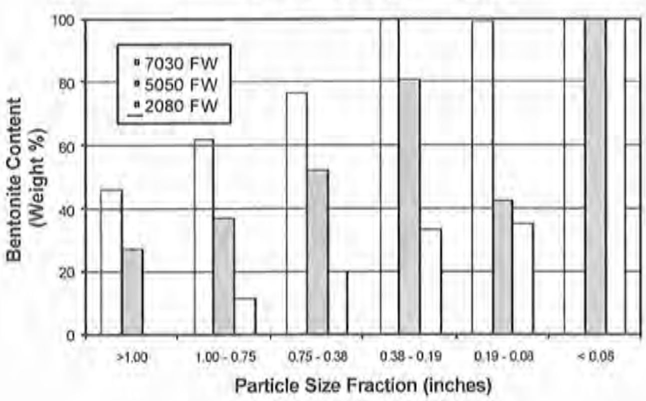


Figure 5. Moisture Content (No. 57 aggregate core)

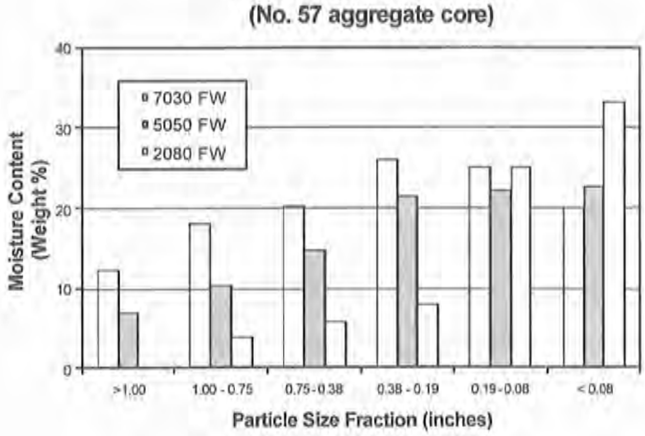
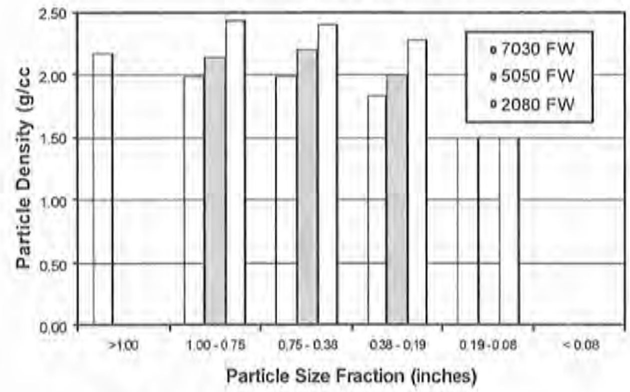


Figure 6. Particle Density (No. 57 aggregate core)



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Testing conducted by Hull & Associates, Inc. for AquaBlok, Ltd.
Report originally prepared by Abeltech, Inc. and revised by AquaBlok, Ltd.

LAST REVISED 1/06/04

Settling Characteristics

AquaBlok™

TEST REPORT #2: Typical Settling Characteristics of Individual and Bulk Masses of AquaBlok™ Particles Through Water

Background and Purpose of Testing

Variable quantities or types of clay minerals can be used to manufacture different AquaBlok™ formulations to accommodate site-specific needs and overall project objectives. The physical characteristics of dry, bulk (mixed) AquaBlok masses as well as discrete grain size classes vary as a function of product formulation (see Test Report #1). Nevertheless, despite differences in physical parameters like bulk density or percent clay content between formulations, bulk samples of AquaBlok consistently display a broad range of particle sizes as well as predictably variable particle densities amongst the size fractions (Test Report #1).

The settling velocity of any single particle through a standing (non-flowing) water column depends on a particle's size, density, and shape, and on water density and viscosity. In general, the settling velocity of a larger particle is higher than that of a smaller particle of the same density and shape. Quantitatively, Stoke's law states that, under such conditions, a particle's settling velocity is proportional to the square of its radius (Day, 1965). Unpublished laboratory research conducted in the University of Toledo's Civil Engineering Department (UT) also indicates that constant (terminal) settling velocities for individual AquaBlok particles of different sizes typically occur within one foot of vertical descent through a standing water column.

In contrast to the relatively predictable settling behavior of individual particles, the settling behavior of bulk (mixed composite) material masses through water is typically much more complex. Bulk material tends to settle as a single entity rather than as individual particles (Dortch, 1990). As a mass settles, shear stresses and drag forces develop at the mass/water interface, resulting in the formation of turbulent eddies within and around the settling mass. According to Dortch (1990), a settling mass tends to reach terminal velocity after falling only a short distance.

The purpose of this laboratory testing was two-fold: (1) to quantitatively demonstrate average settling velocities of individual AquaBlok particles of different sizes through small, standing water columns, and (2) to qualitatively demonstrate settling characteristics of different bulk AquaBlok masses through field-scale water columns. Data related to the settling characteristics of individual AquaBlok particles provide a useful theoretical basis for characterizing the settling behavior of bulk AquaBlok masses through standing water columns, which is more relevant to field applications.

In turn, laboratory observations of settling characteristics of bulk AquaBlok masses through non-flowing water columns provides baseline information that can be used when modeling applications to flowing-water environments.

Methods

Settling Velocity of Individual Particles

Ten representative AquaBlok particles were chosen from selected particle-size fractions of a sieved, air-dry sample of a 5050 FW formulation (see Test Report #1). Each particle was dropped through a 31 inch-tall standing column of municipal tap water at room temperature (~70° F) from just above the water surface and the fall time for each particle was measured with a stop watch to the nearest 0.01 second.

Settling Characteristics of Bulk AquaBlok Masses

The general settling characteristics of bulk masses of 5050 FW AquaBlok were observed as part of several large-scale settling column studies. The studies were conducted using a large (23-inch x 23-inch x 12 foot-tall), steel-reinforced plexiglas settling column. Each AquaBlok mass was applied from just above the water surface by "pouring" the material from a bucket. Relative settling velocities of different sized particles comprising the bulk mass were qualitatively observed, as was the general nature of dispersion and movement of the mass during descent. (continued on back)

AquaBlok

To more closely mimic AquaBlok applications as they occur in the field (e.g. applied gradually from barged stockpiles or shore-based conveyors), the application of AquaBlok masses to standing water columns was continuous and rapid, but not instantaneous. Product application on a less-than-instantaneous basis – although more representative of field practice - precludes precise quantification of settling velocities for bulk settling AquaBlok masses, or a detailed evaluation of how variable mass or water-column thickness may quantitatively affect settling behavior.

Results

Table 1 summarizes results of average settling velocities of individual AquaBlok particles through the small standing water column, while Photograph 1 qualitatively illustrates typical particle-settling and dispersive behavior of bulk AquaBlok masses during descent through large water columns (in this case, approximately 31 pounds of dry AquaBlok descending through a 8.8 foot water column).

Table 1.
Settling Behavior of Individual Particles (5050 FW Formulation).

AquaBlok Particle Size Fraction (inches)	Average Setting Velocity (ft/sec)
1.00 – 0.75	1.94
0.75 – 0.38	1.55
0.38 – 0.19	1.03
0.19 – 0.08	0.72

Typical behavior of a settling AquaBlok mass.

Observations and Conclusions

Individual AquaBlok Particles

Smaller AquaBlok particles tend to settle slower than larger particles (Table 1). This is because smaller particles have lower densities and higher surface-area-to-mass ratios than larger particles. Differences in average settling velocities as a function of particle size probably also occur for other AquaBlok formulations, although actual values may differ.

Based on results of research at UT, average settling velocities reported above should approximate terminal settling velocities for most individual AquaBlok particles.

AquaBlok Particle Masses

Visual observations of typical settling masses (Photograph 1) indicate that, as expected, little to no difference in settling velocities appear to occur as a funtion of particle size when the product is applied as a bulk mass. Instead, the mass tends to behave more-or-less as a single, turbulent and complex entity as it descends through the water column.

When applied as a bulk mass, AquaBlok tends to disperse during descent (Photograph 1). Results of several different column studies indicate that a relatively greater degree of lateral dispersion tends to occur with greater water-column thickness, and that such dispersion may be constrained somewhat (during laboratory testing) when applying large masses of AquaBlok through labratory columns. Empirical observations also indicate that a greater degree of lateral dispersion of the AquaBlok mass typically results in a more spatially uniform distribution of AquaBlok across the targeted sediment surface.

Due to the virtual lack of vertical segregation of AquaBlok particle sizes during bulk-mass descent through a field-scale water column, product segregation is not typically observed within the applied AquaBlok layer as it settles across the targeted sediment area.

References

Day, P.R. 1965. Particle fractionation and particle-size analysis, pp. 545-567 in "Methods of Soil Analysis", Vol. 1, by C.A. Black (Ed.), American Society of Agronomy.

Dortch, M.S., tech. Ed. 1990. "Methods of Determining the Long-Term Fate of Dredged Material for Aquatic Disposal Sites," Technical Report D-90-1, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Miss.

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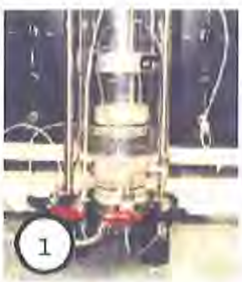
Bench-Scale Permeability: FW Product

AquaBlok™

TEST REPORT #3: Bench-Scale Hydraulic Conductivity of Typical FW AquaBlok™ Formulations in Fresh Water

Background and Purpose of Testing

According to guidance developed by the U.S. Army Corps of Engineers for the U.S. EPA (Palermo et. al., 1998), one principal function of an in-situ remedial sediment cap should be to reduce the flux of dissolved contaminants from sediments into the overlying water column. Contaminants can migrate from sediments into water – including underlying ground water resources - through advective and diffusive processes. Advection refers to the movement of bulk porewaters, the ultimate rate and extent of which is largely a function of gradient and hydraulic conductivity. Advective movement of contaminants involves contaminant movement by "mechanical" or non-chemical means. In contrast, diffusive contaminant movement is the process whereby contaminants dissolved in water are transported by random molecular motion from areas of high concentration to areas of low concentration (Palermo et. al., 1998). The rate and extent of contaminant movement by diffusion is primarily controlled by concentration gradients, however, contaminant attenuation by – or sorption to – reactive substrates like AquaBlok™ can reduce contaminant mobility. AquaBlok's attenuating capabilities are the subject of Test Report #7.



Permeability testing of AquaBlok™ samples.

The permeability (hydraulic conductivity) of typical freshwater AquaBlok formulations to fresh water under saturated conditions is the focus of the current test report.

Methods

Representative samples of three different freshwater AquaBlok formulations – 5050 FW, 4060 FW, and 2080 FW – were used to determine saturated hydraulic conductivity in general conformance with ASTM Method D 5084. Typical physical and compositional characteristics for the range of AquaBlok formulations tested are provided in Test Report #1. One subsample for each of the 5050 FW and 4060 FW formulations was tested whereas four subsamples of the leaner 2080 FW formulation were tested to more accurately determine analytical variability for this method.

Laboratory procedures involved placing masses of dry AquaBlok into flexible-wall permeameters and thoroughly hydrating the samples with de-aired tap water (freshwater) under pressure to assure that samples were completely saturated prior to testing. The pre-saturation process typically took from one to two weeks, until samples stopped taking in water from both ends. After sample saturation, the hydraulic conductivity test was run under constant hydraulic gradients ranging from approximately 17 to 19 cm/cm for 2080 FW samples and from 26 to 28 cm/cm for 4060 FW and 5050 FW samples. According to ASTM D 5084, hydraulic conductivity values are presumably unaffected by variable hydraulic gradients – testing values of which were below the recommended maximum (30 cm/cm) for testing low-permeability (less than 10^{-7} cm/sec) materials. Photograph 1 shows a typical AquaBlok sample during permeability testing.

Results

Testing results are summarized in Table 1, with the typical appearance of AquaBlok samples after testing shown in Photograph 2.

Observations and Conclusions

Saturated AquaBlok is relatively impervious to advective flow and is quantitatively on the order of what would typically be expected for hydrated sodium bentonite, which is the dominant sealant layer component of typical freshwater formulations.

Similarly, low hydraulic conductivity values observed for both the more lean 2080 FW AquaBlok formulation and the relatively bentonite-enriched 4060 FW and 5050 FW formulations implies that the presence of relatively significant quantities of aggregate within the hydrated AquaBlok matrix has an insignificant effect on AquaBlok performance as an effective hydraulic barrier.

Consistently low permeability values for AquaBlok (as shown for the 2080 FW data) can be achieved through controlled laboratory testing, which is testament to both the reproducibility of the testing procedure as well as the inherently low-permeability nature of the AquaBlok's bentonite component.

Table 1.
Hydraulic Conductivity of Different Freshwater AquaBlok Formulations.

AquaBlok Formulation	Hydraulic Conductivity Values (cm/sec)
5050 FW	5.93×10^{-9}
4060 FW	3.94×10^{-9}
2080 FW	Arithmetic Mean $=4.59 \times 10^{-9}$
	Geometric Mean $=4.52 \times 10^{-9}$

Typical AquaBlok Sample after permeability testing.

References

Palermo, M., S. Maynord, J. Miller, and D. Reible. 1998. "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments," EPA 905-B96-004, Great Lakes National Program Office, Chicago, IL.

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Testing conducted by Hull & Associates, Inc. for AquaBlok, Ltd. Permeability data for the 5050 FW formulation from Abeltech, Inc. Report originally prepared by Abeltech, Inc. and revised by AquaBlok, Ltd.
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Field-Scale Permeability

AquaBlok™

TEST REPORT #4: Field-Scale Hydraulic Conductivity of a Typical Fresh-water AquaBlok™ Formulation

Background and Purpose of Testing

Results of bench-scale AquaBlok™ testing indicate that, under controlled laboratory conditions and using standard testing procedures, typical freshwater AquaBlok formulations tested under saturated conditions display very low hydraulic conductivity when permeated with freshwater (Test Report #3). The relatively impervious nature of saturated AquaBlok contributes to its ability to minimize flux of sediment-borne contaminants into adjacent surface or ground-water bodies through minimizing advective pore-water flow. As also discussed in Test Report #3, contaminant flux reduction is considered to be an important function of in-situ remedial sediment caps.

The purpose of this test was to determine the hydraulic conductivity (permeability) of a typical hydrated freshwater AquaBlok formulation on a large (field-equivalent) scale using a recognized and accepted procedure developed for evaluating the efficiency of clay based landfill caps and liners.

Test Method Background and Procedures

The field-scale permeability of hydrated AquaBlok was determined using the Two-Stage Borehole Field Permeability Test developed by Soil Testing Engineers, Inc. – a procedure also commonly known as the Boutwell Permeability Test. The Boutwell Test is a standardized field procedure used for quantitatively evaluating the permeability of rainfall through clay based landfill caps and liner systems. The Boutwell Test is widely recognized and accepted by U.S. EPA, U.S. Army Corps of Engineers, and many state regulatory agencies.

In theory, the Boutwell Test is based on the concept that when the three-dimensional geometry of a substrate's wetted zone is varied systematically, the vertical and horizontal permeabilities also vary in a calculable manner. That is, during "Stage I" of this permeability test, the bottom of a test hole augered into a substrate is positioned flush with the bottom of the cased (and water-filled) hole, allowing for primarily vertical flow from the casing into the substrate. In contrast, "Stage II" of the test involves advancing the test hole several inches beyond the bottom of the water-filled casing, thus allowing for significant horizontal flow through the substrate.

The Boutwell Test has associated with it a number of boundary condition requirements that must be met in order for the test to be considered valid. As described in detail by Boutwell (1992), such requirements range from a minimal thickness of material below the bottom of the test hole during Stage II (8 inches) to a minimum horizontal distance between test holes (20 inches). Personal communication with Dr. Gordon Boutwell confirmed that these and other requisite assumptions and conditions (Boutwell, 1992) were met through conducting our particular permeability test using AquaBlok.

The Boutwell Test was performed outside in two large, (1000-gallon capacity) plastic testing vessels, each equipped with valving and drainage along perimeter sides and bases to allow for gravity drainage from each vessel (in order to meet boundary condition requirements).

Quantities of AquaBlok, similar in composition to the 4060 FW formulation (see Test Report #1), were added and hydrated incrementally in 4- to 6-inch lifts (Photograph 1), with approximately one-day hydration time between lifts. The final, cumulative hydrated AquaBlok thickness in each vessel was approximately 3.5 feet (Photograph 2). At this point, the AquaBlok-filled vessels were ready for installation of the testing devices.

Addition of AquaBlok to testing vessels.

Hydrated AquaBlok prior to instrument installation.

A total of seven permeameters and one TEG (temperature effect gauge) unit were installed in the hydrated AquaBlok, to total depths of about twenty inches below the material's surface (Photograph 3). A hand auger was used to drill the 4.5-inch diameter holes to the required depth, into which each test device was installed. (continued on back)

Instrumented Boutwell testing vessels.

AquaBlok™ Composite Particle System

Permeability testing involved collecting data in two different stages, as described above: Stage I of the test, during which vertical permeability has the greatest affect, was conducted over a period of sixteen days. Once the permeability values for Stage I had apparently stabilized (which took approximately two weeks), Stage II was conducted over a period of ten days. Visual and manual inspection of hydrated (but pre-tested) AquaBlok removed from augered test holes indicated that the bentonite-rich material may not have been fully hydrated during the initial portion of Stage I monitoring.

Table 1. Calculated vertical and horizontal permeability through hydrated AquaBlok (n = 7 samples).

Calculated Vertical Permeability [1]			Calculated Horizontal Permeability [1]		
All values in units of cm/sec					
Value Range 5.70×10^{-9} to 1.12×10^{-8}	Arithmetic Mean 8.65×10^{-9}	Geometric Mean 8.41×10^{-9}	Value Range 2.84×10^{-8} to 3.96×10^{-8}	Arithmetic Mean 3.26×10^{-8}	Geometric Mean 3.23×10^{-8}

[1] Variability (standard deviation) among replicates for the respective calculated values was small, less than 18 percent.

Results and Observations

Results of large-scale AquaBlok permeability testing using the Boutwell test method are summarized in Table 1. For comparison, see Table 1 of Test Report #3 for AquaBlok permeability values determined on a bench scale in the laboratory.

As can be seen in Table 1, calculated mean permeability values for vertical and horizontal flow through hydrated AquaBlok on a field scale are quite low, on the order of 10^{-8} to 10^{-9} cm/sec. If, in fact, the AquaBlok had been fully hydrated during Stage I, the actual vertical component would likely have been lower. Furthermore, AquaBlok permeability on a field scale is comparable to values determined under controlled conditions in the laboratory, which ranged from 3.5×10^{-9} to 5.9×10^{-9} cm/sec for different product formulations (see Test Report #3).

Conclusions

Results of this large-scale field permeability test indicate that AquaBlok - once in place and hydrated in the field – can form not only an effective physical barrier between contaminated substrate and the adjacent environment, but also an effective hydraulic barrier between such ecosystem components. Whether considering a landfill, deepwater, or wetland application scenario, such characteristically low permeabilities would help protect against the downward migration of dissolved contaminants into underlying ground water resources, as well as upward migration of contaminated pore waters into an overlying water column.

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Relative Erosion Resistance

AquaBlok™

TEST REPORT #5: Relative Response of Typical Freshwater AquaBlok™ and Non-Cohesive Substrates to Fluvial-Like Erosive Forces

Side view of AquaBlok™-over-sand sample prior to testing.

Background and Purpose of Testing

According to the U.S. Army Corps of Engineers (Palermo et. al., 1998), one principal function of an in-situ remedial sediment cap – in addition to reducing contaminant flux, as discussed in Test Report #3 – should be to stabilize contaminated sediments, preventing their re-suspension and subsequent transport to other (e.g. downstream) locations. Installation and maintenance-in-place of remedial caps that withstand significant erosional forces related to hydrologically dynamic systems (like rivers or estuaries) will minimize exposure, redistribution, and dispersion of the sediments being capped.

The purpose of this set of laboratory tests was to demonstrate the relative physical resistance of typical freshwater AquaBlok™ and other, less cohesive materials to significant, fluvial-like erosive (shear) forces of known velocity and duration.

Large-scale circulating flume system.

Note that these tests were conducted under highly controlled laboratory conditions and using substrate conditions that my not be representative of actual field conditions. Consequently, the data should not be interpreted as indicative of the expected response of these different capping materials under specific field conditions.

Methods

For several different projects, the relative resistance of a variety of selected AquaBlok formulations, fine-grained sediment, and sand samples have been characterized in the laboratory using a circulating flume system. This flume system (Photograph 1) is comprised of a 7.5-foot long x 4 inch- internal-diameter, clear PVC sample chamber, a pump, and a holding tank that supplies and receives flow to and from the sample chamber. The sample chamber is connected to the rest of the flume system through flexible hosing and threaded unions.

Depending on project needs, specific parameters and procedures for flume testing can vary with respect to induced flow velocities, flow duration, sample size or configuration, pretest hydration periods, etc. Nevertheless, the general procedure typically used during testing of these samples was as follows: a pre-weighed sample was placed into the clear, semi-circular, two-foot-long x 1.5-inch high acrylic sample holder (Photograph 2); samples were typically placed into the holder to result in a surface that was approximately 0.4 to 0.8 inches above the top edge of the holder, thus placing a portion of the sample directly into the flow path.

The sample was then carefully inserted into the sample chamber. Flat and sloped spacer sections were placed into the flume chamber - both "upstream" and "downstream" - to establish more uniform flow over the test sample.

Once the flume chamber was closed and secured, municipal tap water was pumped across the sample surface at controllable flow velocities (as manipulated through the use of in-line valves). The system configuration allows for establishing and periodically checking flow velocities by diverting flume-chamber discharge from the holding tank into a volume-calibrated drum and measuring the time required to pass a specific water volume across the test sample. Flow velocities over a given sample - in units of feet per second - could then be calculated using bulk-flow measurements together with estimates of the cross-sectional surface area over the top of a sample. Flow velocities are referred to in terms of approximate ranges because cross-sectional areas can vary along sample length (due to variable surface topography) and also over time (due to continued clay hydration and/or erosional losses).

After testing, a sample can then be removed from the chamber and reweighed to estimate mass loss through erosion. The physical response of samples during and after testing can also be evaluated in various ways, including: visual observation and video documentation, pre-/post-test weight comparisons, or estimating clay loss based on typical, pretest AquaBlok™ compositions (Hull et al., 1998). (continued on back)

AquaBlok™

Results and Observations

Results of multiple flume tests indicate that relatively insignificant AquaBlok erosion occurs at flow velocities as high as 5 to 6 ft/sec, and for continuous flow durations for up to several days. Photograph 3 illustrates typical AquaBlok sample response to flume testing.

Typical plan-view appearance of AquaBlok sample after testing (red ribbons are flow indicators).

In contrast to AquaBlok's relative resistance to shear stresses under relatively high-flow conditions, erodability is typically high for sand and unconsolidated, fine-grained sediments at flow velocities of approximately 2 ft/sec or less, and for flow periods of as short as 10 to 20 minutes. Such unconsolidated saturated materials can display 90 percent mass loss under these relatively passive flow conditions.

In a related note, results of laboratory flume tests conducted by others (e.g. Gailani et al., 2001) indicate that adding even small amounts of bentonite (a principal component of typical freshwater AquaBlok formulations) to relatively non-cohesive topsoil and sand materials can greatly reduce material erosion rates, thus enhancing the stability of these materials for sediment capping.

Conclusions

Laboratory study of relative resistance of typical freshwater AquaBlok to shear stresses invoked under various testing conditions indicates that AquaBlok is relatively resistant to considerable - and sustained - fluvial-like erosive forces. Consequently, sediments occurring in fluvial environments and overlain by AquaBlok or AquaBlok-based capping systems could remain in place and physically stabilized during relatively high-flow events (e.g. a 100-year flow event). Depending on site conditions, AquaBlok-based cap designs could include a surficial armoring component, if relatively higher flows are expected.

In contrast, other materials such as less-cohesive sediments and sands prove less resistant to erosive forces. Depending on a site's hydrologic/hydraulic conditions, capping of sediments with less shear-resistant materials like sand may not offer the same degree of sediment stabilization as can AquaBlok-based capping, or could require excessive thicknesses of sand that could interfere with waterway navigation.

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Results

Testing results are summarized in Figures 2 and 3.

Observations and Conclusions

Photograph 1B illustrates the typical appearance of AquaBlok after hydration and expansion. Note pore-space infilling and thickness increase over time.

Regardless of product formulation (eg. 2080, 4060, etc.) or aggregate gradiation (AASHTO aggregate type in parenthesis), approximately linear relationships exist between mean dry thickness and coverage rate, as expected (Figure 2). A similar relationship also exists between mean hydrated thickness and coverage rate, with dry trends typically paralleling hydrated trends for most formulations.

Relatively thinner applications of dry product tend to expand greater than do thicker applications (Figure 3A), primarily because of the slow rate of water migration into central portions of product.

As a result of relatively slow water flow into progressively greater thicknesses of product, the wet bulk density tends to increase with increasing coverage rate (Figure 3B). This also results in lower moisture content with increasing dry product thickness (Figure 3C).

Figure 2. Dry and Hydrated Product Thickness as a function of formulation, aggregate size gradation, and coverage rate.

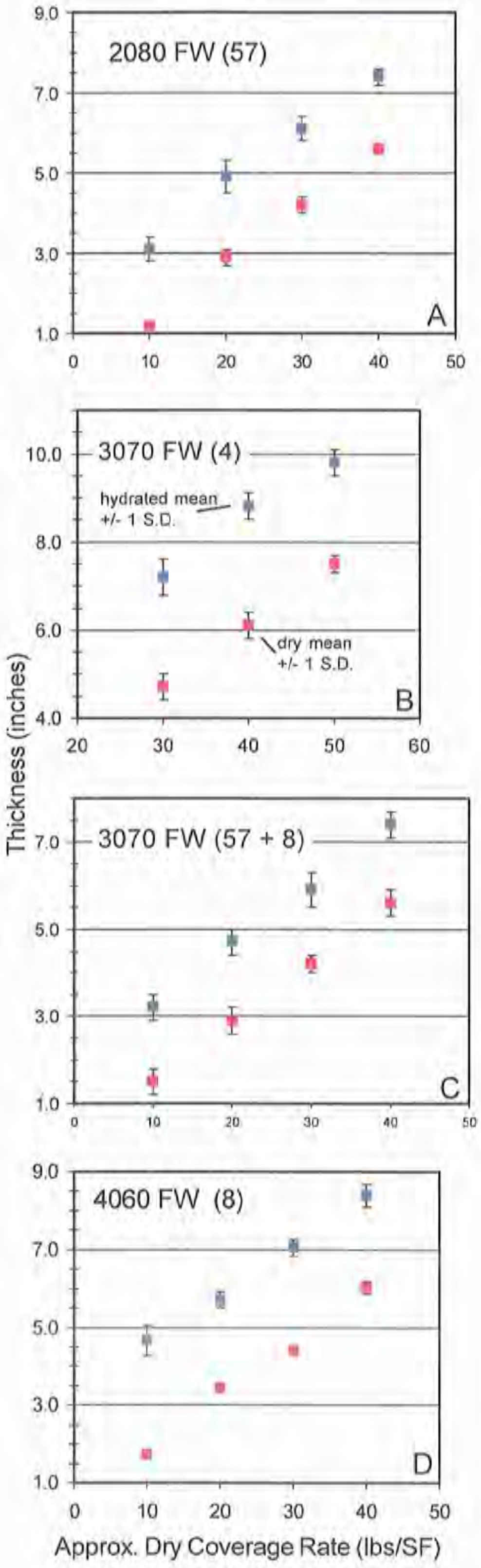
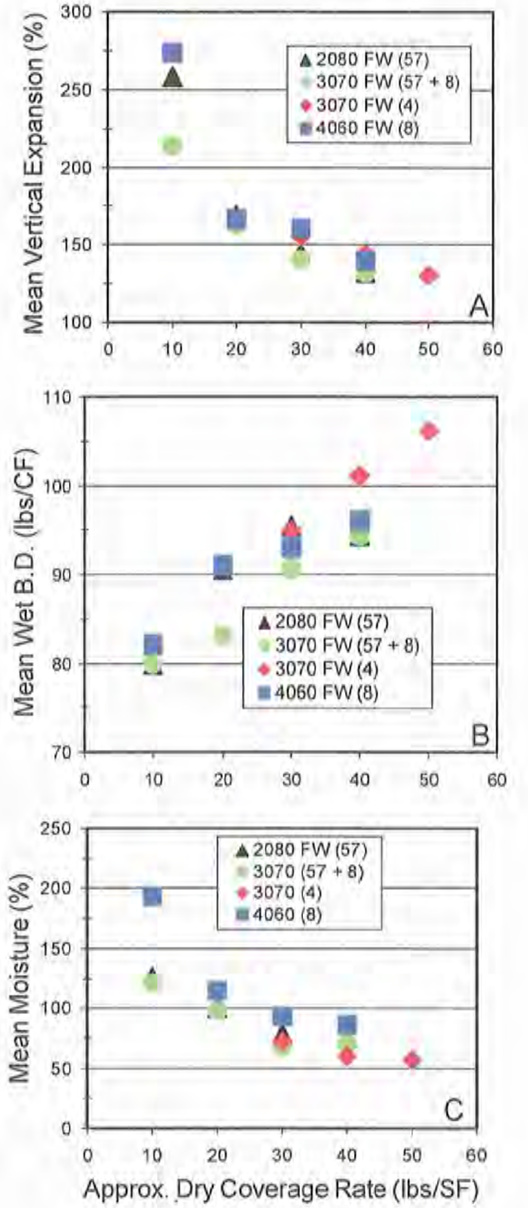


Figure 3. Mean Wet Bulk Density, Vertical Expansion, and Percent Moisture of Hydrated Product.



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Chemical Attenuation

AquaBlok™

TEST REPORT #7: Contaminant Attenuation by Freshwater AquaBlok™ Formulations

Clay minerals are natural and essentially inert, with physical and chemical properties that are well understood. They have long been used in the environmental industry to contain or isolate various hazardous substances, primarily because of their relatively low permeability to aqueous solutions. In particular, bentonite, which is a geologic deposit rich in smectite clays, has been used extensively as an integral component of drilling fluids, in landfill liner and capping systems, and in slurry walls for diverting ground water flow. Bentonite is a principle component of typical freshwater formulations of AquaBlok™ (Test Report #1) and not only has substantial merit as a hydraulic barrier (Test Report #3), but as a chemical barrier as well.

Because of its mineralogical and surface-charge configuration, montmorillonite – typically the major component of bentonite - has an inherently large surface area compared to other commonly occurring "plate-like" clay minerals (Table 1). This high surface area, in combination with water's affinity for montmorillonite's negatively charged surfaces, results in significant physical expansion of the clay upon its hydration (Test Report # 6). The high surface area and negatively charged surfaces also account for the clay's ability to sorb or exchange relatively large quantities of dissolved cations (Table 1).

Table 1. Physical and Chemical Properties of Montmorillonite and Other Selected Phyllosilicate Minerals (from Bohn et. al., 1979).

Clay	Surface Area (m^2/g)	Expands Upon Hydration?	Cation Exchange Capacity(meq/100g)
Montmorillonite	600 - 800	Yes	80 – 120
Mica	20 - 40	No	70 – 120
Kaolinite	10 – 20	No	1 – 10

Table 2. Heavy Metal Sorption from Solution onto Montmorillonite and Bentonite (from Bereket et. al., 1997[1] and Lothenbach et. al., 1997[2]).

Heavy Metal	Bentonite[1] (initial solution pH = 5)	Montmorillonite[2] (pH between ~ 4 and 7)
	-------- Percent of Metal Removed from Solution --------	
Lead	82	20 – 100
Copper	56	20 – 100
Zinc	34	20 – 40
Cadmium	71	15 – 20
Nickel	No data available	15 – 20

Published research indicates that naturally occurring montmorillonite and bentonite can not only sorb innocuous base-metal cations like calcium, magnesium, and sodium, but can also sorb – or attenuate – potentially toxic heavy metal cations onto clay surfaces, effectively minimizing concentrations of such metals in bulk solution phase of pore and surface waters. Batch-shaking and flow-through column studies typically indicate significant removal of dissolved metal cations like lead, copper, zinc, cadmium, and nickel from solution onto montmorillonite and bentonite (Table 2).

The degree of metal attenuation by montmorillonite and bentonite differs between charged metal species and also with system variables including: pH, competition between metals for exchange or sorption sites, total salt concentrations in solution, oxidation-reduction potential, presence of dissolved organic substances, and speciation of metal ions in solution.

For example, lead and copper typically sorb more strongly to most clay mineral surfaces, including montmorillonite, than do zinc and cadmium, and metal sorption is usually greater, overall, in higher-pH systems. Published research also generally indicates that, despite such systematic factors affecting ion sorption, heavy metal cations are held more strongly to montmorillonite and bentonite than are mono- and divalent base-metal cations. Additionally, a relatively greater degree of metal sorption occurs to montmorillonite than to other, lower surface-area clays like kaolinite. In many situations, oxides of iron, manganese, or aluminum can accentuate heavy metal sorption to clay rich substrates. (continued on back)

AquaBlok

In light of demonstrated abilities for metal sorption/attenuation under controlled laboratory conditions, montmorillonite and bentonite have both been used in different capacities in the environmental industry to: immobilize heavy metals in contaminated soils and sediments, remove metals from landfill leachates, and remove metals from waters and wastewaters. Due to its low permeability and radionuclide-sorbing capabilities, bentonite is also commonly considered for use as an environmental buffer material during disposal of radioactive wastes. Such remedial uses of these clay and clay rich materials will likely increase, as should development and use of chemically modified versions of montmorillonite and bentonite clays for selective attenuation of organic pollutants.

Specially engineered cation-like compounds, such as quaternary ammonium ions, can be used to physically displace base cations, like sodium, from exchange sites of montmorillonite clays. The use of tetramethylammonium (TMA+) ions is one example (Figure 1).

Reactive surfaces of these "organoclays" or organobentonites are more organophilic in nature (compared to non-modified clays) and, as a result, have a relatively greater affinity for charged and non-charged organic pollutants. Published research indicates that organoclays can selectively remove a variety of organic pollutants including non-polar, nonionic BTEX compounds, phenols and chlorinated hydrocarbons, and pesticides (Figure 1). As with metal-clay interactions, the degree of attenuation by organoclays is dependent on factors like pH and competition for clay sorption sites. Organoclays have been used commercially in water and wastewater treatment systems for the removal of organic pollutants from contaminated ground waters and industrial waste streams (including oils and greases). Organoclays have also been tested for use in the solidification/stabilization of phenolic-contaminated soils.

The bentonite component of typical freshwater AquaBlok formulations, either in bentonite's natural or modified form, can effectively reduce concentrations of heavy metals and organic pollutants in the bulk solution phase. However, other types of clay minerals, hydrous oxides, and/or other reactive materials can also be used in conjunction with bentonite to develop special AquaBlok formulations designed to address site-specific needs, including sediment capping in saline environments.

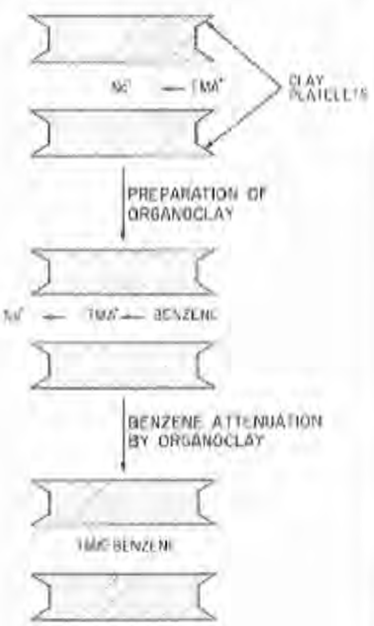

Figure 1. Contaminant Attenuation by Organoclays.

In summary, AquaBlok and AquaBlok-based caps can minimize the migration of toxic, harmful compounds from moving into ground water, or into floral or faunal communities inhabiting overlying deepwater or wetland ecosystems. AquaBlok's inherently low permeability accentuates its ability to isolate pollutants from such environments. Therefore, AquaBlok not only acts as a relatively cohesive, physical and hydraulic barrier between contaminated sediments and water resources, but can also be mineralogically and compositionally tailored to maximize chemical attenuation of specific metal or organic pollutants, depending on site-specific conditions and needs.

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Freeze/Thaw Effects

AquaBlok™

TEST REPORT #8: Freeze/Thaw Effects on AquaBlok™

Background and Purpose of Testing

For some ecosystems, including seasonally exposed wetlands occurring in northern regions, the potential exists for periodic exposure of substrates to climatically induced freeze/thaw effects. The effects of cyclic freeze/thaw on the physical structure and conductive properties of different clay mineral-based landfill capping and lining materials have been investigated by others, both in the laboratory and field. Results of these studies generally indicate that while the physical structure and hydraulic conductivity of many compacted clay materials can be adversely affected by freeze/thaw (e.g. Bowders and McClelland, 1994; Benson and Othman, 1993), that of geosynthetic clay liners, or GCLs, is typically not affected (U.S. EPA, 1996). The relative resilience or "healing" abilities of GCLs is largely attributable to the bentonite component in GCLs; bentonite is a principle component of typical AquaBlok formulations.

The purpose of this testing was to qualitatively demonstrate effects of cyclic freeze/thaw on the physical appearance of hydrated samples of typical AquaBlok material.

Methods

Five samples of hydrated AquaBlok (5050 FW formulation) were prepared in four-inch square, clear-plastic containers. The containers were selected to allow for observation of freeze/thaw effects, and to minimize confining pressure on the samples.

Hydrated test sample prior to freezing.

500 mls of municipal tap water and an approximately 2-inch thick layer of dry AquaBlok particles were added to each container. The particles were then hydrated by periodically adding water to achieve material saturation. The volume of each sample approximately doubled through hydration and expansion, with total hydrated AquaBlok volumes ranging from about 1,100 to 1,200 cubic centimeters (Photograph 1).

Each sample was then subjected to a total of five freeze/thaw cycles and the physical condition of the samples after each cycle were observed and documented.

Results and Observations

Each freezing event produced discrete, open fractures (typically less than 1/4-inch in width) which contained free water that probably migrated from water on top of the sample. None of the observed fractures penetrated entire sample thicknesses. The positions and orientations of these freezing fractures were noted by tracing them with a marker on the containers (Photograph 2). All fractures completely closed, or "healed", upon thawing of the samples.

Subsequent freezing events produced new fractures of different position and orientation, implying that planes of weakness do not form in the hydrated product. Again, these newly formed fractures healed upon thawing of the samples. No fractures persisted from one freeze/thaw cycle to the next (Photograph 3).

Representative test sample after third freezing event – note fractures.

Representative test sample after third thawing event – note healing of fractures.

Conclusions

Freezing of hydrated AquaBlok samples produces discrete, open fractures, however, the fractures do not penetrate the total sample thickness.

Freeze-induced fractures heal, and the mass of hydrated AquaBlok returns to its original, relatively homogeneous state upon thawing. Such an AquaBlok response to cyclic freeze/thaw would generally be expected, based on published literature.

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TEST REPORT #. 9

Physical Product Characteristics in Saline Waters

Background and Purpose of Testing

Freshwater compatible (sodium bentonite-based) AquaBlok typically displays significant primary pore infilling and net vertical expansion when hydrated in fresh water, as described in Test Report No.6. This is because of the dominant clay's (sodium montmorillonite) plate-like structure, highly charged surface area, and great affinity for water - attributes that, in low-salinity environments, result in the clay's dispersed, physically expanded state.

While significant dispersion and expansion of this clay material in low-salinity waters is well recognized and is, in fact, a key principle behind the functioning of environmental barriers like slurry cutoff walls, equally notable is the relative *lack* of sodium bentonite's expansion in saline waters and in some chemically aggressive waters (e.g. Tobin and Wild 1986; Shackelford 1994). Sodium Bentonite's solution-dependent behavior, as illustrated in Photograph 1, is due to montmorillonite's tendency to flocculate rather than disperse in the presence of high ionic-strength solutions.

Sodium bentonite's sensitivity to high ionic-strength waters is also dynamic. The introduction of highly saline or chemically aggressive waters into an initially dispersed slurry wall system, for example, can result in clay flocculation, increased permeability and, in extreme cases, wall failure (Birdwell 2001; D'Appolonia and Ryan 1979; Day 1994).

Other types of clay minerals display a much lower sensitivity to high ionic-strength waters, or to changes in water chemistry over time. One such mineral is attapulgite (a.k.a. palygorskite). Attapulgite has a needle-like structure, a relatively high but minimally charged surface area, and a lower affinity for water – attributes that result in this mineral displaying minimal flocculation or swelling potential, regardless of the chemistry or salinity level of the hydrating water (e.g. Tobin and Wild 1986; Shackelford 1994). Attapulgite's markedly independent behavior with respect to ionic strength or salinity effects is demonstrated in Photograph 2.

Because of its attributes, and the fact that attapulgite can provide for adequately low and stable hydraulic conductivity (see Test Report No. 10), its use in various environmental barriers is increasing (Birdwell 2001; Day 1994; Galan 1996; Murray 2000). Attapulgite's recognized performance in high saline and other chemically aggressive waters form the basis for its inclusion into some saline formulations of the AquaBlok product.

Published literature also points to advantages associated with using *blends* of clays, like attapulgite plus sodium bentonite, in some environmental barrier systems (Murray 2000; Stern and Shackelford 1998), thus providing justification for including similar blends in other saline formulations of the product.

Calcium bentonite is another type of clay rich material that, similar to attapulgite, tends to show relatively less reactivity (and greater stability) when contacted with high ionic-strength and chemically aggressive waters than does its sodium-rich counterpart (e.g. Alexiew 2000; Koch 2002). As a result of such properties, calcium-rich bentonites are more often being considered for use in environmental barriers (e.g. Dananaj et al., 2005; Koch 2002). Laboratory based experimentation on the relative effectiveness of calcium bentonite-based AquaBlok products and their potential use in saline environments is ongoing.

Physical compaction or loading of barrier materials placed into terrestrial environments (e.g. landfills, subterranean disposal facilities, etc.) can significantly reduce primary porosity, thereby reducing hydraulic conductivity and increasing barrier effectiveness (Shackelford 1994; Daniel 1994; Komine 2004). The concept of increasing barrier effectiveness through loading should also apply to subaqueous environmental barriers as well, despite the countering influence of buoyancy effects. Empirical laboratory observations indicate that sediment barriers comprised of saline AquaBlok formulations may benefit from such loading.

Photo 1. Sodium Bentonite-Based Product Hydrated in fresh (left) versus high saline waters (right).

Photo 2. Attapulgite-Based Product Hydrated in fresh (left) versus high saline waters (right).

In this test report, information is presented related to selected, dry and hydrated state characteristics of chosen saline formulations hydrated in either full-strength seawater or in brackish waters. Also presented are data related to the potential effects that loading, either during or after hydration, could ultimately have on the physical characteristics of saline-compatible barriers.

Materials and Methods

Several saline formulations were tested, including two attapulgite-based formulations (4060 SW and 5050 SW) and two blended clay formulations (3070 SW and 5050 SW). Each of the blended formulations included equal dry weight percentages of sodium bentonite and attapulgite clay. The core component for all four formulations comprised crushed limestone aggregate nominally equivalent in size and gradation to AASHTO No. 8 aggregate.

Data presented in this report were developed using the same types of testing equipment and generally following the same methods used to obtain similar data for freshwater formulations (see Test Report No. 1 and No. 6).

For current testing, saline product samples were placed in even, single lifts at dry coverage rates ranging from ~ 20 to ~ 60 pounds per square foot (lbs./SF). For most testing, waters with a salinity level equal to typical full-strength seawater (~ 36 parts per thousand, ppt) were used as the hydrating liquid. A commercially available seawater salt mix was used to prepare the testing solutions and a calibrated specific conductance meter (with temperature correction) was used to verify the target salinity (i.e. electrical conductance) level. The chemical composition of the prepared seawater solutions was verified against the composition of typical seawater.

To demonstrate the effect that physical loading could potentially have on the hydrated thickness of saline product and on the relative abundance of residual primary porosity, sand or aggregate was placed overtop several selected samples at loading rates ranging of from ~ 20 to ~ 50 lbs./SF. Loads were applied either immediately following dry product placement or within two to three days after product had had the opportunity to hydrate and expand un-loaded.

Furthermore, to demonstrate the influence of salinity level on product hydration and expansion as a function of clay type, additional testing was conducted involving the use of variable-strength seawater solutions, at target salinity levels of ~ 9, 18, or 36 ppt, to hydrate two selected saline formulations (5050 SW attapulgite and 5050 SW clay blend). For comparison, one selected freshwater (sodium bentonite-based) product formulation (3070 FW) was also tested. For this testing, all formulations were placed at a dry coverage rate of ~20 lbs./SF.

Results

Dry state characteristics are presented in Figure 1. Mean dry and hydrated thickness values in full-strength seawater as a function of formulation and coverage rate, and with or without immediate or delayed loads applied for selected coverage rates, are included in Figures 2A through 2D. Figures 3A through 3C summarize net vertical expansion, wet bulk density, and percent-moisture, respectively, for all saline formulations combined. Mean dry and hydrated thickness values for SW and FW formulations as a function of salinity and coverage rate are included in Figures 4A through 4C.

Selected photographs are also included for a typical series of column tests conducted for a given saline formulation (Photograph 3) and also to illustrate some formulations' apparent physical responses to the influence of immediate versus delayed loading (Photographs 4 through 7).

Figure 1. Typical Density and Porosity Values for Selected Saline Formulations.

Product Formulation	Aggregate Core	Average Partical Density of Dry Product (g/cm^3)	Approximate Inter-partical Porosity (percent)	Dry Bulk Density, Typical Range (lbs/ft^3): 65 – 70 – 75 – 80 – 85
3070 SW attapulgite	No. 8	2.24	48	
4060 SW attapulgite	No. 8	-----	-----	
5050 SW attapulgite	No. 8	1.74	36	
3070 SW clay blend	No. 8	2.38	45	
5050 SW clay blend	No. 8	1.75	32	

Figure 2. Dry and Hydrated Thickness of Saline Formulations as a Function of Coverage Rate and Loading. Hydrating Water Salinity ~36ppt. (no load applied unless noted)

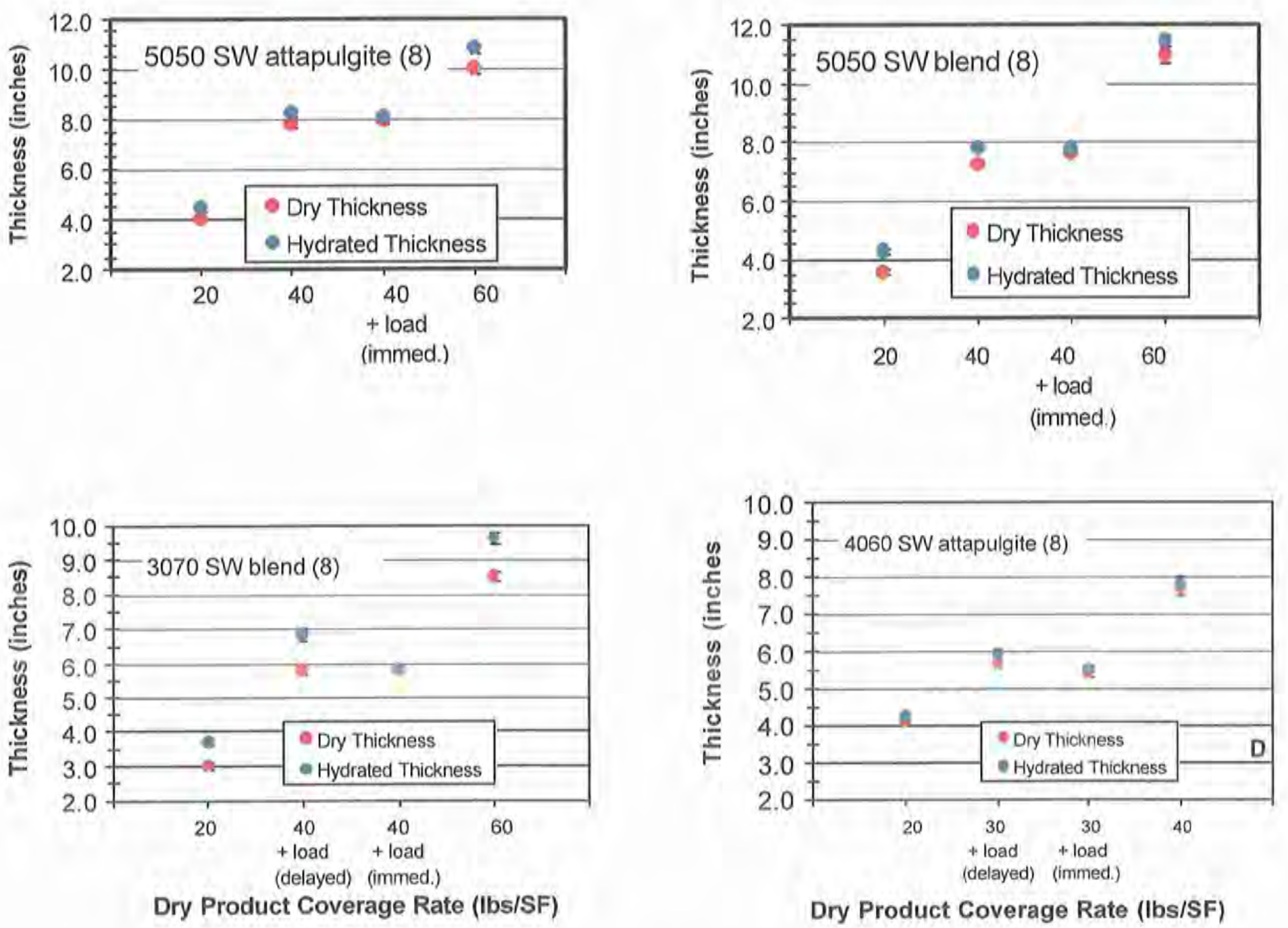


Photo 3. Typical Series of Column Tests.

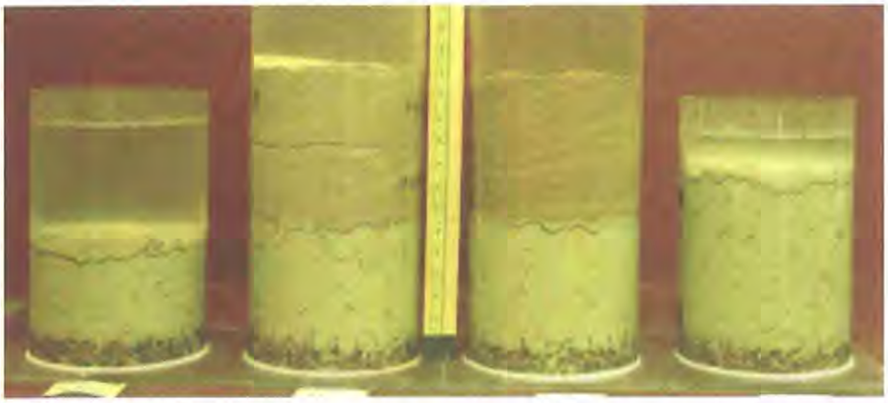


Figure 3. Mean Net Vertical Expansion, Wet Bulk Density, and Percent Moisture of Hydrated Product.

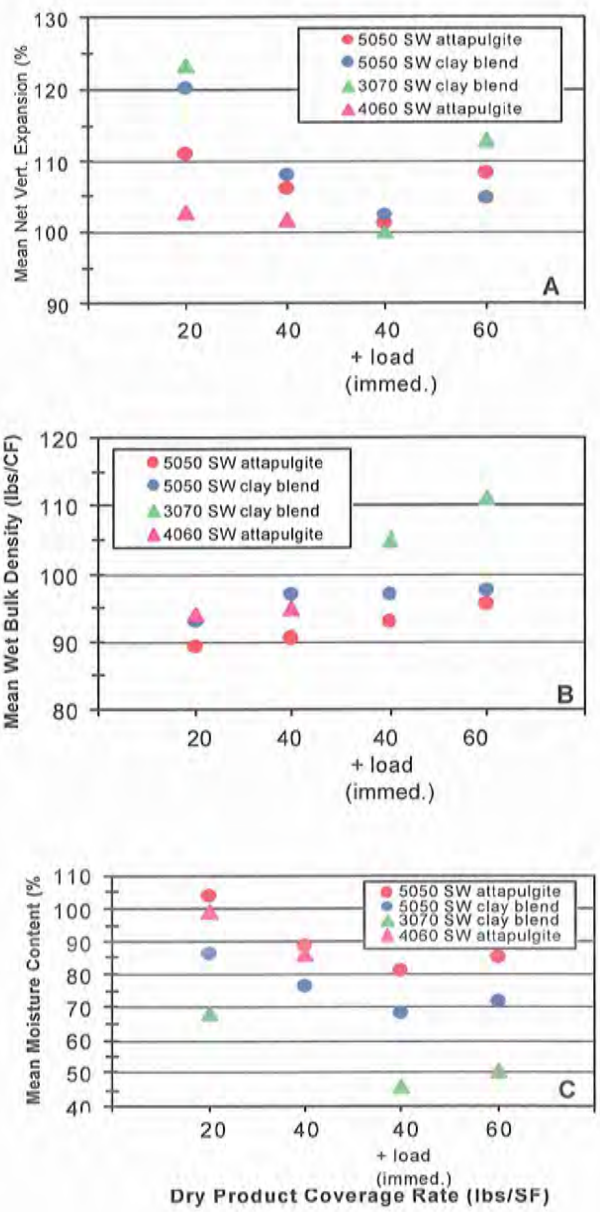
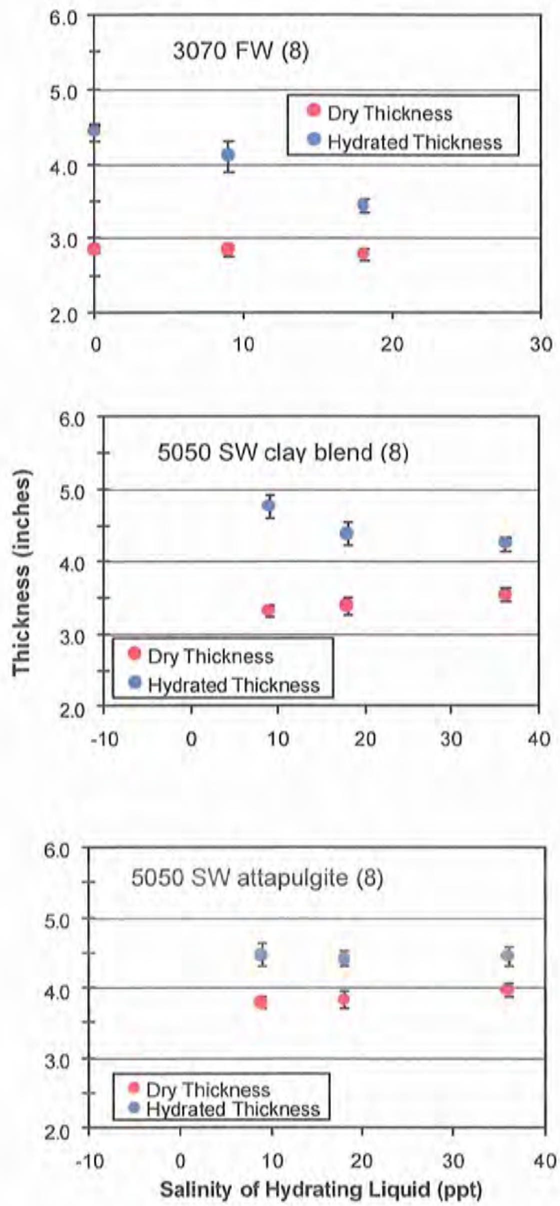


Figure 4. Dry and Hydrated Product Thickness as a Function of Formulation and Salinity of Hydrating Water (dry coverage rate ~20 lbs/SF).



Observations and Conclusions

Dry particle density and especially dry bulk density values for attapulgite-based materials tend to be somewhat lower than for comparable blended clay formulations (Figure 1), which are, in turn, typically lower than freshwater formulations (see Test Report No. 6). This is probably due to the lower specific gravity of attapulgite, 2.58 g/cc, relative to that for bentonite, 2.82 g/cc (Shackelford 1994).

Once hydrated, saline formulations, particularly attapulgite-based material, display relatively little net vertical expansion in full-strength seawater, as illustrated in Figures 2A through 2D. The low-expansion character of saline formulations in high-saline waters, as summarized in Figure 3A, is especially noteworthy when compared to the significant expansion displayed by freshwater formulations in fresh water (see Figure 3A of Test Report No. 6).

As with dry state characteristics, wet bulk density values for saline formulations also tend to vary as a function of clay type, with attapulgite-based product displaying slightly lower values than comparable blended formulations (Figure 3B). These trends in wet bulk density are accentuated by the lower moisture content of blended product (Figure 3C).

Figure 4 confirms what was conceptually demonstrated in Photographs 1 and 2: that a progressively lower degree of vertical expansion occurs as freshwater product is hydrated with increasingly saline waters (Figure 4A), whereas variable salinity levels have less effect on the expansion of saline formulations, particularly attapulgite-based product (Figures 4B and 4C). The salinity dependent behavior of freshwater formulations is also reflected in greater hydraulic conductivity values when freshwater product is permeated with increasingly saline permeants (see Table 1 of Test Report No. 10).

As expected, hydrating saline product under an immediately placed load greatly minimizes its net vertical expansion, whereas a limited degree of net expansion is observed when saline product is allowed to hydrate two or three days prior to load placement (Figure 2; Photographs 4 through 7).

Previously cited literature implies that loading of capping material may be an appropriate step towards construction of effective saline-product barriers in saline environments. Nevertheless, the optimal *timing* for load placement as well as the extent of loading may depend on a number of factors. For example, in some cases, product compaction encouraged by immediate loading may effectively restrict the flow of hydrating waters into macropore spaces, resulting in a greater abundance of residual porosity, at least over the short term (Photographs 4 and 6). This is in contrast to the significant primary pore infilling which may occur for the same types of saline formulations upon allowing them to first hydrate a few days before loading (Photographs 5 and 7).

The technical and economic advantages of applying sand and/or aggregate loads over saline product, including the most appropriate timing for load placement, are aspects of cap design and construction that should be evaluated on a case-by case basis.

Photo 4. 3070 SW Clay Blend, 40lbs./SF (immediate load).

Photo 5. 3070 SW Clay Blend, 40lbs./SF (delayed load).

Photo 6. 4060 SW Attapulgite, 30lbs./SF (immediate load).

Photo 7. 4060 SW Attapulgite, 30lbs./SF (delayed load).

Material Selection and Placement

The results presented herein highlight important questions to consider when contemplating design and construction of clay based sediment barriers in impacted brackish or saline sediment environments, including: Which attapulgite-based or blended product formulation should be used at a given site? At what coverage rate should the chosen dry product formulation be placed to achieve a particular target hydrated thickness? Or, should a load be placed overtop the product and, if so, what should the load be (composition and rate) and when should it be applied?

Adequate answers to these and related questions will typically involve a consideration of various factors such as site-specific conditions (e.g. salinity levels, sediment characteristics, ecological attributes, etc.), construction timeframe and sequencing, relative costs for capping materials and placement, etc. The primary consideration, though, is often a clarification of the performance-related results that are sought through sediment capping. For example, if achieving a low-permeability barrier (equal to or less than 10^{-7} cm/s) is the primary performance goal for a particular capping project, then issues such as those discussed in Test Report No. 10 should be considered.

On the other hand, if physical isolation of contaminated sediments from bioturbating benthic organisms is the target performance goal, then hydrated cap thickness may be a principle design consideration (Clarke et al. 2001). This will also require the recognition that, for most saline applications, the target hydrated cap thickness is more-or-less the placed (dry) thickness.

Or, if minimizing cap permeability and benthic isolation are both project goals, then consideration could be given to surcharging hydrating (or hydrated) capping product with an appropriate thickness of granular material, e.g. sand, that is particularly attractive habitat for local benthic communities.

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TEST REPORT #10

Bench-Scale Hydraulic Conductivity as a Function of Product Formulation and Permeant Salinity

Background and Purpose of Testing

In situ capping is a viable alternative for managing contaminated sediments in various aquatic environments, including fresh, brackish, and saline waters. Creation of a relatively low-permeable barrier is often an important management goal when capping sediments in all such environments.

As illustrated in Test Report No. 9, different formulations of the AquaBlok barrier technology – including those containing sodium bentonite (reactive clay, sodium montmorillonite), attapulgite (a.k.a. palygorskite), or clay blends (sodium bentonite plus attapulgite) - tend to hydrate and expand to varying degrees when exposed to waters of different salinity levels. In addition to differences in *physical* responses, the different product formulations can also display varied *hydraulic* responses as a result of recognized differences in the permeability (hydraulic conductivity) of bentonite and attapulgite based materials to saline waters (e.g. Stern and Shackelford, 1998; Tobin and Wild, 1986; Day, 1994). An understanding of the salinity environment into which the capping material is being placed is critical to determining the most appropriate formulation, and coverage rate, required to achieve a target thickness and permeability for a proposed cap.

The permeability of some clay based environmental barriers can also depend on the *stage* or *sequence* at which saline waters are permeated. For example, the hydraulic conductivity of sodium bentonite-based materials to saline waters can be significantly lower, at least in the short term, if the material is first hydrated and permeated with freshwater (Lin and Benson, 2000; Shackelford, 1994). This and other factors should be considered when determining the most appropriate product formulation for site use – and even the best timing for product placement – in that many impacted coastal (estuarine) environments display significant spatial and temporal variability in salinity levels.

Summarized in this test report are hydraulic conductivity values determined for selected freshwater and saline (attapulgite- or clay blend-based) product formulations permeated with waters of either constant or variable salinity over time.

Methods

Representative samples of selected freshwater (FW) and saline (SW) formulations (n = 1 for each formulation) were permeated with waters of different salinity levels in the laboratory using flexible-wall permeameters (constant head). Testing was conducted in general conformance with ASTM Method D5084, as was freshwater product testing (see Test Report No. 3). Cell pressures during testing ranged from approximately 10 to 40 psi and hydraulic gradients were varied from less than 5 cm/cm to slightly over 30 cm/cm.

Samples tested included a number of selected FW or SW formulations manufactured using different clay types (sodium bentonite, attapulgite, or a clay blend); different clay to aggregate weight ratios (2080 to 5050); and a couple different aggregate sizes and gradations. Additional testing details are provided in Tables 1 and 2.

Permeant (input) salinity values ranged from 0 parts per thousand, ppt (de-aired tap water), up to approximately 36 ppt, which is equivalent to that of typical undiluted, or full-strength, seawater. When testing freshwater formulations, input salinity values were held constant at 0, 8 to 9, and approximately 18 ppt (Table 1). Values were held constant at approximately 36 ppt when testing saline formulations (Table 2). A commercially available seawater salt mix was used to prepare saline solutions at target levels and a calibrated specific conductance meter (with temperature correction) was used to verify target levels. The chemical composition of the prepared seawater solutions was verified against the known composition of typical seawater.

In addition to conducting flexible-wall permeameter testing, a series of rigid-wall permeameter tests (falling head) were also conducted on several selected formulations using permeants containing variable salinity levels over time. Testing was conducted in general accordance with accepted methodology and procedures. Multiple pore volumes of first full-strength seawater then freshwater were continuously passed through each of several different clay rich formulations (5050 FW, 5050 SW attapulgite, and 5050 SW clay blend) over an approximately 30 to 40-day period. The electrical conductivity of volumes of discharge waters emanating from the base of each column was also tracked during testing.

Results

Flexible-wall permeameter values for selected FW product formulations permeated with waters of different yet constant salinity levels, and at different hydraulic gradients, are presented in Table 1. Values for selected SW formulations permeated with full-strength seawater, also at different gradients, are presented in Table 2.

Results of rigid-wall permeameter testing of different FW and SW formulations using permeants of variable input salinity over time are portrayed in Figures 1 through 3.

Table 1

Hydraulic Conductivity of Selected Freshwater AquaBlok Formulations as a Function of Permeant Salinity and Hydraulic Gradient

Freshwater Product Formulation [1,2]	Approx. Permeant Salinity	Hydraulic Conductivity as a Function of Hydraulic Gradient (in units of cm/cm)						
	(ppt)	<5	5-10	10-15	15-20	20-25	25-30	>30
2080 FW	0	–	–	–	–	8.1×10^{-9} [4]	–	–
	8 [3]	4.0×10^{-8}	5.7×10^{-6}	–	–	–	–	–
	9	–	5.4×10^{-8}	6.6×10^{-8}	–	6.5×10^{-8}	–	6.2×10^{-8}
	18	–	1.0×10^{-6}	1.7×10^{-6}	5.9×10^{-6}	–	6.0×10^{-6}	6.0×10^{-6}
3070 FW	8 [3]	1.3×10^{-8}	1.2×10^{-8}	–	–	–	–	–

Footnotes:

1. "2080 or "3070" indicates relative percentages of clay and aggregate, by dry weight. "FW" indicates a freshwater (sodium bentonite-based) product
2. Aggregate used to prepare product nominally equivalent in size gradation to AASHTO No. 6 aggregate.
3. Permeant liquid comprised of relatively calcium- and chloride-rich wastewater (I.e. pond water from a specific project).
4. Please see Test Report No. 3 for additional conductivity data derived by permeating fresh water through various FW product formulations.

Table 2

Hydraulic Conductivity of Selected Saline AquaBlok Formulations to Full-Strength (~36 ppt) Seawater as Function of Hydraulic Gradient

Clay Type in Sealant Layer	Saline Product Formulation [1,2]	Hydraulic Conductivity as a Function of Hydraulic Gradient (units of cm/cm)						
		<5	5-10	10-15	15-20	20-25	25-30	>30
Attapulgite (palygorskite)	3070 SW	5.9×10^{-5}	--	--	3.1×10^{-5}	--	1.4×10^{-5}	--
	4060 SW	--	1.6×10^{-7}	--	3.2×10^{-7}	--	4.0×10^{-6}	--
	5050 SW	--	7.8×10^{-8}	8.6×10^{-8}	--	8.3×10^{-8}	3.1×10^{-7}	--
	5050 SW [3]	--	--		7.0×10^{-8}	--	--	--
Clay Blend	3070 SW	--	7.5×10^{-8}	--	7.6×10^{-8}	--	1.0×10^{-7}	--
	5050 SW	--	4.9×10^{-8}	--	4.8×10^{-8}	--	5.3×10^{-8}	--

Footnotes:
1. "5050" or "2080" indicates relative percentages of clay and aggregate, by dry weight. "SW" indicates a saline (attapulgite or clay blend) product formulation.
2. Unless noted otherwise, aggregate used to prepare product nominally equivalent in size gradation to AASHTO No. 8 aggregate.
3. Aggregate core comprises a blend of equal quantities of nominal AASHTO No. 8 and No. 57 aggregate.

Observations and Conclusions

Flexible-Wall Permeameter Testing Results

Although low permeability values (10^{-8} to 10^{-9} cm/s) can be achieved when permeating freshwater formulations with fresh and even brackish waters, higher flow (as high as 10^{-6} cm/s) tends to occur when the same formulations are permeated with higher-saline waters (Table 1). This phenomenon has generally been observed by others (e.g. Stern and Shackelford, 1998; Stewart et al., 2003; Day, 1994) and illustrates the relative sensitivity and physical instability of sodium bentonite (montmorillonite) in higher-saline environments, particularly in terms of the clay's tendency to flocculate in the presence of high concentrations of salts, which leads to increased effective porosity and, ultimately, increased permeability.

Nevertheless, because permeability values equal to or less than 10^{-7} cm/s are considered appropriate for different types of clay based barriers in a variety of environmental applications (Tobin and Wild, 1986; Sallforg and Hogsta, 2002; US EPA, 1998; Dunn and Palmer, 1994), data in Table 1 also imply that some FW formulations - particularly those relatively enriched in clay – can be used to create appropriate, effective hydraulic barriers in brackish waters with salinity levels of up to at least 8 or 9 ppt. The appropriateness of using FW formulations – rather than SW formulations - to meet project-specific goals in impacted brackish/estuarine, or even wastewater-pond, environments should be evaluated on a project-specific basis.

In contrast to the relative sensitivity of FW formulations to higher saline permeants, the permeability of attapulgite-based materials – particularly those with relatively high clay content – typically remain at or below 10^{-7} cm/s when permeated with full-strength seawater solutions (Table 2). Similarly low permeability values are also seen when attapulgite-based product is permeated with less saline waters, including freshwater (data not shown). The current work also indicates that relatively higher permeability values, up to 10^{-5} cm/s, may occur for less clay rich, attapulgite-based formulations when infiltrated with full-strength seawater (Table 2). Nevertheless, the relative physical and hydraulic insensitivity (stability) of attapulgite-based materials to salts and other chemically aggressive solutions (organic leachates, acidic solutions, etc) - in contrast to the relative sensitivity and instability displayed by many bentonite-based materials to such permeants - has been noted by others (Shackelford, 1994; Galan, 1996; Tobin and Wild, 1986).

Physical loading of saline formulations (during or following hydration) may have a positive influence on reducing barrier permeability by reducing residual porosity through compression or compaction of the hydrating/hydrated material mass (see Test Report No. 9).

As also indicated in Table 2, permeameter values for formulations manufactured using a *blend* of clays and permeated with full-strength seawaters are also relatively low, on the order of 10^{-8} cm/s. Similarly low values were also observed when lower-salinity waters, including freshwater, were used as the permeant (data not shown). However similar, test results for blended formulations (Table 2) appear to differ from results for attapulgite-based formulations in two important respects: (1) values for relatively clay rich, blended formulations (e.g. 5050 SW) appear to be somewhat lower than for similar, attapulgite-based formulations and (2) values for less clay rich, blended formulations (i.e., the 3070 SW formulation) are up to several orders of magnitude lower than for similar, attapulgite-based formulations.

The positive effect that blending attapulgite with sodium bentonite can have on the physical as well as hydraulic stability of environmental barrier materials in high salinity systems and in other chemically aggressive environments has been recognized by others (e.g. Murray 2000; Stern and Shackelford, 1998).

Rigid-wall Permeameter Testing Results

Results of rigid-wall permeameter testing of selected FW and SW formulations generally corroborate results of flexible-wall testing (Figures 1 through 3). Recognized differences in equipment, testing methodologies, etc. usually preclude direct, quantitative comparisons of the two types of data, and it is generally accepted that rigid-wall tests tend to overestimate hydraulic conductivity values (Shackelford, 1994), as also seen herein.

As illustrated through flexible-wall testing, rigid-wall results once again generally reflect the relatively high sensitivity of sodium bentonite-based materials to permeants of variable salinity (Figure 1) in contrast to the relative insensitivity, or stability, of attapulgite-bearing materials to the same, temporally variable permeants (Figure 3). Blended clay formulations tend to display an intermediate hydraulic response (Figure 2).

To summarize, attapulgite- or blended clay based formulations of the AquaBlok product are as appropriate for use within saline environments as are bentonite-based formulations for use at freshwater sites. And although not typically applicable to higher salinity environments, some bentonite-based formulations can also be effective in some brackish environments. The level of appropriateness will depend on a number of factors (spatial and temporal ranges in salinity values; prevailing surface-water salinity

Figure 1. Testing of 5050 FW (poorly graded)

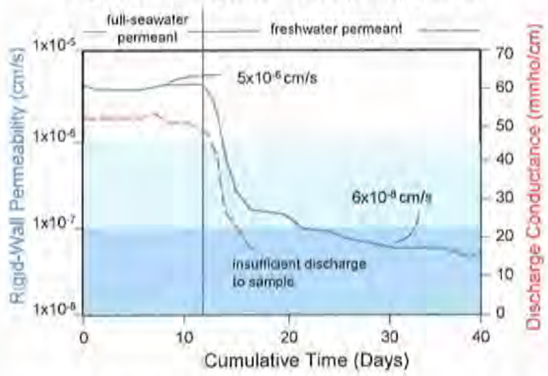


Figure 2. Testing of 5050 SW Clay Blend (poorly graded)

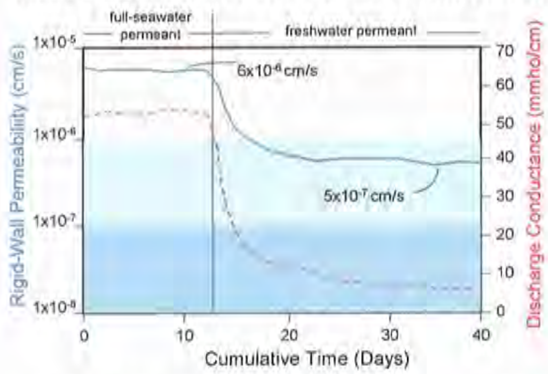
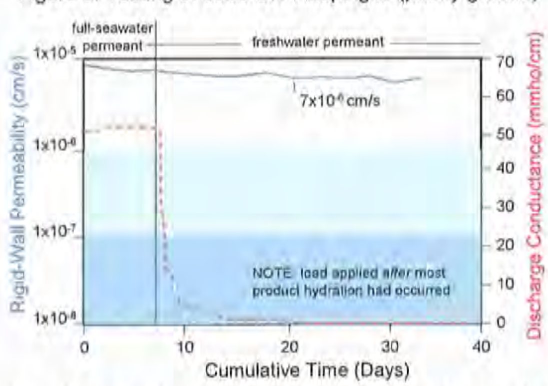


Figure 3. Testing of 5050 SW Attapulgite (poorly graded)



values during product placement; target cap thickness; etc.) and should be evaluated on a case by case basis.

Furthermore, if achieving a particular, target permeability value is a primary goal for remedial cap performance at a specific saline site, then the most appropriate saline formulation for use in the project could involve a number of additional considerations, including: allowable tolerance range for meeting the target value; an understanding of the relationship between water-column salinity and water depths, including whether or not a significant salt wedge periodically occurs at the site and when/where the wedge occurs; target cap design and relative product costs; etc.

Material Selection

Results presented herein indicate that blended clay formulations (rather than attapulgite-based product) are probably more appropriate for use in sediment cap designs for most full-seawater environments; surcharging with sand or aggregate loads, either during or after product hydration, may help consolidate barrier material and increase its ultimate effectiveness. Relatively clay rich, attapulgite-based formulations may also be effective in some full-seawater systems, and could be more appropriate than blended product for use in other chemically aggressive environments, depending on the dissolved or pure-phase contaminants involved.

The laboratory data and literature presented herein also imply that, although sodium bentonite-based product is not usually appropriate for typical full-seawater environments, it could, in fact, be effective and appropriate for barrier construction in estuarine environments, where significant spatial and temporal variability exists in salinity levels, and where adequate "windows" of less saline (and more brackish) waters may occur during which the freshwater product could be applied. The appropriateness of applying sodium bentonite-based product in saline or brackish environments should be evaluated on a case by case basis.

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Last Revised 01/14/05

TEST REPORT # 11 SHEAR STRENGTH LABORATORY TESTING RESULTS OF AQUABLOK® 2080 FW AND 3070 FW (NO. 8 AGGREGATE)

Background and Purpose of Testing

The low conductivity and chemical attenuation capabilities, discussed in previous test reports, demonstrate AquaBlok as a practical alternative for *in-situ* contaminated sediment sequestration. However, to achieve optimal results an *in-situ* capping project should be treated as an engineering project with carefully considered design, construction, and monitoring (Palermo, 1998). Thus, in addition to the above-mentioned qualities there must be a good understanding of the geotechnical properties of various formulations of AquaBlok. Summarized in this test report are results of geotechnical laboratory testing performed on AquaBlok 2080 FW (i.e., 20:80 percent clay to aggregate by dry weight) and 3070 FW – AquaBlok design mixes that are typically used for capping applications. The results can be used to verify the stability of this AquaBlok formulation for specific applications. The samples were prepared using aggregate nominally equivalent in size gradation to AASHTO No. 8 aggregate, which is considered representative of material to be used during cap construction.

Methods

The tests were carried out as close as possible to the procedures outlined in their respective American Society for Testing and Materials (ASTM) standard. Deviations were necessary in some instances due to the uniqueness of the AquaBlok material. The tests were carried out under close supervision of an engineer and followed practical engineering theories and applications. All laboratory tests were performed on samples hydrated with de-aired tap water.

Results

Consolidated Undrained (CU) Triaxial Test (ASTM D4767, AASHTO T297)

CU triaxial tests (two points each set) with pore-water pressure measurements were performed. The samples were considered completely hydrated and were sheared at a lateral pressure of approximately 1 and 2 tons per square feet (tsf). The results from the CU triaxial tests provided an effective internal friction angle of approximately 25.8 degrees and a cohesion of 140 pounds per square feet (psf) for the 2080 FW formulation and 5.5 degrees with a cohesion of 280 psf for the 3070 FW formulation (See test results below).

CU Triaxial Test Results

	Total	Effective
2080 FW		
Cohesion (psf)	180	140
Ø (degrees)	11.7	25.8
3070 FW		
Cohesion (psf)	200	280
Ø (degrees)	4.4	5.5

Unconsolidated Undrained (UU) Triaxial Test (ASTM D4767, Saturated)

UU triaxial tests (two points each set) were performed on the same material as the CU triaxial tests. Each of the samples was considered completely hydrated and was sheared at lateral pressures of approximately 0.3 and 0.5 tsf. The results from the UU triaxial tests demonstrate a cohesion of 520 psf with an internal friction angle of zero degrees for the 2080 FW formulation and 300 psf with an internal friction angle of zero degrees for the 3070 FW formulation (See test results below).

UU Triaxial Test Results

	2080 FW	3070 FW
Cohesion (psf)	520	300
Ø (degrees)	0.0	0.2

Unconfined Compression (UC) Test (ASTM D2166)

One UC test was performed on a completely hydrated sample of each formulation using the same material as the triaxial tests. The result from the UC test indicated an apparent undrained shear strength of 220 psf for the 2080 FW formulation and 360 psf for the 3070 FW formulation (See test results below). Theoretically, these results should be equivalent to their respective shear strengths determined in the UU triaxial tests. Since UC tests are commonly performed on fine-grained homogenous materials and AquaBlok is a mixture of fine grained material and aggregate, it is suggested that results from the UU triaxial test may provide a more reliable undrained shear strength value and should be used for most preliminary stability analyses when using AquaBlok product as capping material.

Observations and Conclusions

The results from the triaxial tests corroborate that a leaner mixture formulation (i.e., smaller percent clay to aggregate by dry weight ratio) provides higher shear strengths. Furthermore, the triaxial test results tend to suggest that the shear strength of the 3070 FW formulation is similar to the characteristics of pure bentonite soil (probably due to the relatively larger percentage of the bentonite component).

This test report should not replace a detailed laboratory testing program or stability calculations, but can be used for most preliminary stability analyses. It is recommended that a detailed engineering design be performed to verify mix designs using site specific parameters. This should also include additional shear strength testing of AquaBlok considered representative of the material that will be used on the project.

AquaBlok®
Composite Particle System

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The test reports are also available on our website at: www.aqublokinfo.com.

Last Revised 02/03/06

General Information and Permeability of Blended Barrier Technology

TEST REPORT #12 HYDRAULIC CONDUCTIVITY OF A BLENDED BARRIER AQUABLOK FORMULATION

Background

AquaBlok® is a patented, composite-aggregate technology resembling small stones and typically comprised of a dense aggregate core, clay or clay sized materials, and polymers (Figure 1). For typical formulations, AquaBlok's clay (sealant) component consists largely of bentonite clay. However, other clay minerals can be incorporated to meet project-specific needs.

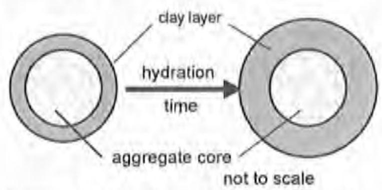

Figure 1. Configuration of Typical AquaBlok Particle.

AquaBlok particles expand when hydrated, with the degree of net vertical expansion determined largely by the formulation, application thickness, and salinity of hydrating water. When a mass of particles is hydrated, it coalesces into a continuous and relatively soft body of material. Once developed, the hydrated AquaBlok can act as an effective physical, hydraulic, and chemical barrier by virtue of its relatively cohesive and homogeneous character, low permeability to water, and chemically active (sorptive) nature, which can be enhanced by the addition of reactive amendments.

Typical Use of AquaBlok

For many projects, AquaBlok use generally involves applying dry masses of AquaBlok through the water and across the surface of contaminated sediments.

Figure 2. Placement Options

A variety of application methods have been implemented, such as: barges, clamshells, stone slingers, conveyors, and many more (Figure 2). The ease of placement and low permeability make AquaBlok a practical method for addressing contaminated sediments. A conventional AquaBlok cap consists entirely of AquaBlok particles and typically displays a permeability of approximately $5x10^{-9}$ cm/s.

Blended Barrier Technology

A Blended Barrier cap is a cost-effective solution for:

- ***situations where sediment contaminant levels are relatively low,***
- ***for post-dredging capping of residual sediments.***

It has been established that mixing AquaBlok with readily available aggregates can create a "Blended Barrier" that does not significantly increase the permeability as compared to an AquaBlok only cap.

Figure 3. Permeability of Select Blended Barrier Formulations

AquaBlok Formulation	Aggregate Size	Resulting Blended Barrier Formulation[1]
#8 3070 FW	AASHTO #8	$2.32x10^{-8}$
#8 3070 FW	AASHTO #57	$1.71x10^{-8}$

1. Blended Barrier is comprised of 50% AquaBlok and 50% aggregate

This results in a very effective contaminated sediment cap for most applications that may be more cost effective than a standard AquaBlok only cap. Implementation of a Blended Barrier AquaBlok cap for lower budget applications, and/or in conjunction with dredging, can provide a barrier for contaminated residual sediment remaining in the uppermost biologically active layer of sediment, and help reestablish altered bottom contours.

Additionally, by varying AquaBlok and aggregate particle size, control over various properties of the cap can be obtained, thus creating a more versatile cap that can be easily engineered for project specific applications. Some examples of such caps are providing a low permeability layer at the sediment/cap interface with an armored layer at the cap/water interface, a geotechnically stable layer at the sediment cap interface with a low permeability layer at the water cap interface, or a semi-permeable cap with pathways targeting contaminants to a treatment surface.

Placement of a Blended Barrier Cap

Any of the previously noted placement methods are applicable for the placement of the "Blended Barrier" AquaBlok cap (Figure 2). For shallow water applications (<40 ft.), the mixing of AquaBlok and aggregate particles obtained from a local source is necessary prior to placement. For deep-water applications (>40 ft.) it may be necessary to utilize a modified placement method, alternating layers of AquaBlok and aggregate particles. When hydrated, the AquaBlok particles will infill the aggregate particles creating a relatively uniform barrier layer.

An Application for Your Project

The innovation of Blended Barrier Technology creates a cost-effective, extremely versatile AquaBlok cap. Whether the goal is to create a barrier over contaminated sediments, reestablish bottom contours post-dredging, establish a contaminant free habitat for benthic organisms, create a semi-permeable reactive cap to treat contamination, or address the inflow of contaminated ground water into an aquatic system, an AquaBlok cap can be engineered for your unique application.

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Last Revised 02/03/06

SPECIFICATION SHEET #13

AquaGate+ORGANOCLAY™

PROVEN REMEDIATION PERFORMANCE OF ORGANOCLAY DELIVERED IN AN AQUATIC SETTING

Background

AquaBlok® is a patented, composite-aggregate technology resembling small stones and typically comprised of a dense aggregate core. In this application of the technology an organoclay coating is utilized with polymers (Figure 1). In other AquaGate+ applications various alternative treatment materials can be incorporated to meet project-specific needs.

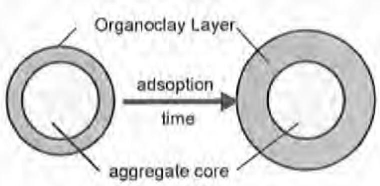


Figure 1. Configuration of an Organoclay Coated Particle.

AquaGate+ORGANOCLAY particles adsorb oil and a wide range of hydrocarbon-based contaminants when contact is made in sediments. As the particles chemically bind the contaminants, the clay layer will expand. At a point when the full mass of the organoclay is achieved the particles coalesce into a continuous and relatively soft body of material, decreasing the permeability of the layer. The AquaGate+ORGANOCLAY layer can also be used in conjunction with a standard AquaBlok cap layer to form an even lower permeability barrier layer above the sediment, if desired.

Organoclays are organically modified clays, typically produced by blending surfactants and clay minerals. This blend creates a new product, a surfactant with a solid base. By means of a partition process, the modified clays will fix non-polar organic compounds. In contrast to activated carbon, by which organic compounds are adsorbed into pores in the carbon and quickly become fouled, the partitioning phenomena takes place outside of the clay particles, minimizing the fouling problem.

Applications of AquaGate+ ORGANOCLAY Technology

Organoclays are a proven remediation technology that addresses a wide range of hydrocarbon-based contamination. The following is a partial list of typical sites and/or contaminants where AquaGate+ ORGANOCLAY cap can be a cost-effective solution:

- ***MGP Plants,***
- ***Wood Treating Facilities,***
- ***Creosote,***
- ***Coal Tar (BTEX),***
- ***PCBs,***
- ***PAHs / NAPL***

Although it has been established that similar weight of organoclay materials will remove, by means of partitioning, up to 7 times the rate of activated carbon, activated carbon can provide further absorption of trace amounts that may not be fully removed by organoclay. Thus, the materials can be used in series in a complimentary manner in some applications requiring very low levels of treatment.

Photo 1. Example Design Mix – 300g of AquaGate+ORGANOCLAY 4060 Blend Sample (120g of Active Organoclay), 3wks After Addition of 185ml Motor Oil.

Generally, AquaGate+ ORGANOCLAY is expected to adsorb between 50-100% of the total weight of the organoclay present in the particle. This percentage of organoclay can vary from 20-40% depending on the desired cap / treatment design and contaminant material and concentration.

Additionally, by varying aggregate particle size, control over various properties of the cap can be obtained, thus creating a more versatile cap that can be easily engineered for project specific applications.

Use of AquaGate+ORGANOCLAY

For many projects, use of the product will generally involve applying dry masses of the material through the water and across the surface of contaminated sediments or directly onto pools of free product. The material can also be placed below other more permeable capping materials such as sand or directly on soil/sediments in the dry if an area has been dewatered.

The use of organoclay in an AquaBlok matrix provides for an efficient delivery and placement option for materials that may otherwise be subjected to erosion by stream flow, wave action, or tidal fluctuations.

A variety of application methods have been implemented for similar materials, such as: barges, clamshells, stone slingers, conveyors, and many more. The ease of placement and ability to place AquaGate+ ORGANOCLAY through a water column creates a practical method for addressing sediments contaminated by oils, PCBs or other difficult hydrocarbon based COCs.

Funnel & Gate Approach

An AquaGate+ORGANOCLAY cap can be configured as a "gate" with a "funnel and gate" system to selectively capture discharges from submerged seeps of upland plume related discharges. Should breakthrough eventually occur, the gate material can be effectively removed and the gate replaced with fresh material. By capturing the product at the seep source, relatively modest volumes of material need to be handled as opposed to using oil sorbent booms and pads, etc. to capture and cleanup seeps that discharge through the water and rise to the surface.

AquaGate+ORGANOCLAY Compatible Product Manufacturers

AquaGate+ORGANOCLAY has been produced and tested with organoclay product available from the following manufacturers:

- *Aqua Technologies of Wyoming, Inc.*
- *Biomin, Inc.*
- *CETCO (Div. of Amcol, Intl.)*
- *Polymer Ventures, Inc.*

In addition, AquaGate+ORGANOCLAY material can be manufactured with other amendments, such as Adventus Group's ZVI or EHC products (see www.adventusgroup.com), to be used to deliver a treatment "train" approach for complex sediments with multiple contaminants.

Bench-Scale Testing & Application and Modeling

While organoclays were originally developed as a water treatment medium, they have more recently received consideration for sediment remediation applications, and when delivered to the sediment water interface as an AquaGate+™ amendment, the range of applications increases. In addition, when used in the manufacture of AquaGate+ ORGANOCLAY, cost efficiencies can be realized as a result of the more effective placement option.

Although other variations exist, the typical applications of AquaGate+ ORGANOCLAYs would be one of the following:

- A composite cap with AquaGate+ORGANOCLAY overlain by sand or other non-reactive material can be an effective remedy where contaminated sediments were transplanted to a deposition area that is not related to a continuous upland source.
- A composite cap with AquaGate+ORGANOCLAY used to consolidate semi-suspended sediments (especially those with petrochemical components) prior to the application of a low permeability standard AquaBlok® cap layer.
- As a treatment gate material in a "funnel and gate" configuration with standard AquaBlok or other low permeable capping material to direct flow through the AquaGate+ ORGANOCLAY treatment media, either through gate columns set at specific intervals, or laterally under a complete cap for capture along the entire cap length, essentially creating a long, thin horizontal column with significant residence times.

There are multiple manufacturers of organically modified clays and the individual products demonstrate different performance attributes as the chemicals of concern, levels of contamination, and salinity of the application area vary. In addition, different organoclays demonstrate varying swell factors, which are an important design consideration. AquaGate+ORGANOCLAY has been successfully manufactured using a variety of organoclays from multiple vendors. ***Table 1 & 2*** demonstrates the relative efficiency of one such product (manufactured by Biomin, Inc.) at removing a surrogate vegetable oil in a series of three small column tests designed to demonstrate the effect of varying particle size (and resulting pore size and volume) and residence time, (which is a function of flow-through rates and column length). ***Figure 2*** graphically demonstrates this relationship between particle size (a 1/4" particle size vs. 3/8" particle size) and, in the case of the duplicate 3/8" particles, runs at different flow-through rates and how these variables affect the removal efficiency and the ultimate time (and pore volumes) for significant contaminant breakthrough.

The use of specifically designed bench scale tests can be very effective at selecting specific organoclays for particular applications (see Reible et al, University of Texas at Austin, *Organoclay Laboratory Study – McCormick & Baxter*, September 2005) and the selection of the appropriate AquaGate+ particle size and layer thickness. Similarly, simple bench scale testing can also determine the appropriate application rates of specific AquaGate+ORGANOCLAY applications for use as a flocculant to consolidate free-product layers and semi-suspended sediments to facilitate more efficient removal by dredging or excavation, or to create a stable base prior to the installation of a clean cap to meet restoration goals.

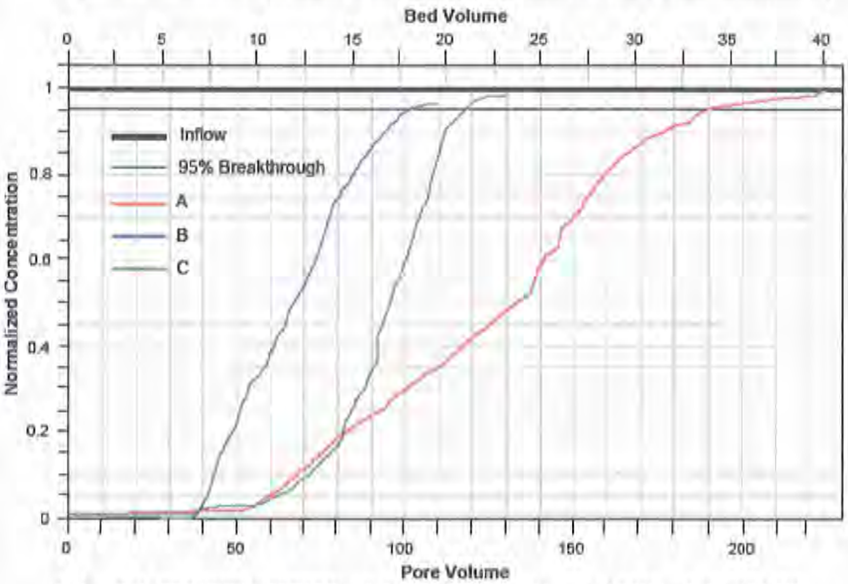
The results of bench scale testing can be used in conjunction with flow models to design composite systems that meet long-term risk assessment goals and subsequent targeted remediation goals, while minimizing overall project costs.

Table 1 (*)

Sorbent	Mass Sorbent (kg)	Mass Sorbent (lb)	Porosity	Flowrate (mL/min)	Flowrate (gal/hr)	Residence (min)
A	0.16	0.34	0.19	2.4	0.038	30
B	0.155	0.341	0.21	7.0	0.114	10
C	0.157	0.345	0.20	3.8	0.061	21

Table 2 (*)

Sorbent	Breakthrough PV	Breakthrough BV	Breakthrough min	Mass Sorbent (kg)	Mass Sorbent (lb)	Mass Sorbed/Mass Sorbent (mg/kg)	Mass Sorbed/Mass Sorbent (lb/lb)	Mass Sorbed/Mass Sorbent (% by sorbent)
A	207.7	39.5	6471	35687	0.079	223043	0.223	22.3
B	101.9	20.4	4256	15702	0.035	98139	0.098	9.8
C	117	23.6	9526	24518	0.054	156163	0.156	15.6



A - AquaBlok+ORGANOCLAY (30/70 Blend), 1/4" size, 30 min. residence and 3,810 mg/L Vegetable Oil.
B - AquaBlok+ORGANOCLAY (30/70 Blend), 3/8" size, 10 min. residence and ~3,400 mg/L Vegetable Oil.
C - AquaBlok+ORGANOCLAY (30/70 Blend), 3/8" size, 21 min. residence and ~3,400 mg/L Vegetable Oil.

Figure 2. Example Design Mix Variables (*)

(*) Independent testing completed by Vinka Cramer, Ph.D. and James Smith, Ph.D. for Biomin, Inc. on sample AquaGate+ORGANOCLAY material, manufactured by AquaBlok, Ltd. using a Biomin, Inc. supplied Organoclay.

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Web: [illegible]

Last Revised: January 2, 2008

SECTION 2

INFRASTRUCTURE

2. ENVIRONMENTAL REMEDIATION

UNDERSTAND THE CHALLENGES TO CREATE SOLUTIONS:

The Sanford Millyard has obvious remnants of its industrial past. From the mill buildings themselves to old boiler plants and the lone remaining smoke stack. Less obvious are the contaminants that lurk within buildings and the landscape itself. Utilizing Environmental Protection Agency (EPA) Brownfield Assessment and Cleanup Grant funding as well as other sources, the Town of Sanford and their consultants performed a number of investigations of sites located throughout Sanford, however most of the efforts were focused on the Millyard Area. Specifically, the town conducted assessments, cleanups and engineering improvements at No.1 Pond, International Woolen Mills, Aerofab Mill, Sanford Mill, Map J29 Lot 17E, and multiple parcels located north of the main mill complex including the riverside area, the Stone parcel and new roadway parcels.

Services ranged from Phase I and II Environmental Site Assessments (ESAs) to building demolition and cleanup of impacted soil, pre-characterization prior to new roadway construction, engineering improvements and bank stabilization at No.1 Pond, as well as post remediation engineering including capping, structural evaluations and parking lot construction, and pre-characterization prior to construction of a new transportation hub for the Town of Sanford. In addition funds were used to develop a vision for the Millyard area. As part of the original assessment grant, the Town of Sanford developed a vision for a riverwalk. This vision was utilized to generate interest in this forgotten corner of the town.

The vision, combined with initial assessment on selected Millyard parcels leveraged future funding including the Revolving Loan Fund and the Cleanup grant for the Aerofab building. Additionally, the assessment and cleanup activities leveraged CDBG funding for the construction of a new road to provide access to the Millyard area. The construction of the new road has been critical in attracting developers to the Millyard complex and collectively, these efforts have paved the way for the area-wide planning grant, which has funded this comprehensive planning effort for the Millyard area.

Sanford's textile production required a wide variety of chemical components that ranged from petroleum to solvents. Today's stormwater impacts continue the process of accretion of contaminants from roadway run-off. **The site's past and present must**

be managed in order to mitigate the effects that these chemical compounds had and will continue to have on soil and groundwater. Further, there is evidence of groundwater impact from upgradient off-site sources at some of the Millyard properties.

REMEDIATION OPTIONS:

The remediation strategy for the Millyard is to systematically contain, treat, or remove contaminants within each parcel to prepare them for renovation and redevelopment. Through community engagement, it was clear that public opinion is strongly in favor of a comprehensive cleanup that may include a variety of remediation technologies**. A collaborative approach will be needed to work with various property owners in the Millyard, while furthering environmental cleanup and redevelopment activities on the various parcels**. While the Town has been successful in securing both assessment and cleanup money for many of their brownfields, there is still work to be done throughout the Millyard.

In May 2012 Sanford was awarded an additional $800,000 in EPA Brownfields funding. $400k has been earmarked for assessment and the other $400k divided into two grants; one for hazardous cleanup at the CGA site on New Dam Road and the other for petroleum-related cleanup at a parcel in the Millyard envisioned as a parking facility and as an access point to the Mousam River. The Assessment Grant will allow the Town of Sanford to leverage this infusion of capital to bring various and disparate mill building owners to the table to develop a strategic plan to tackle continued remediation needs within the Millyard.

DEVELOP A GAME CHANGER

Extension of natural gas service into the Millyard area could provide the incentive for perspective tenants to relocate to Sanford. Currently, natural gas lines are located approximately 4.2 miles away from the Millyard at the Sanford airport. The most logical route to extend service between the airport and the Millyard is along route 109; Main Street. Unitil has indicated that extension of a natural gas main along this route might cost $XXX per linear foot to install. Securing commitments to tie into the gas system from enough perspective customers currently located in Sanford (e.g Sanford Hospital) would increase the feasibility that Unitil would construct the gas main as opposed to only constructing the main for the purpose of solely serving the Millyard initially.

INFRASTRUCTURE ANALYSIS

WATER:

The fire protection capacity of the Millyard is excellent. According to representatives from Sanford, there is approximately 9,000 gpm of fireflow available at a residual water pressure of 20 psi in the distribution system. However, additional information regarding the age of the water main infrastructure, material of the pipes and the repair history of the water mains in the area might dictate whether replacement of the infrastructure is warranted.

In addition to potable water mains for drinking and firefighting purposes, the Millyard area contains raw water penstocks for mill use. It should be noted that the flow control for the penstock mains, which directs water from the Number One pond in Sanford through the Millyard, are difficult to operate. Should the need arise to utilize these mains again; caution should be taken when operating the flow control devices.

SEWER AND DRAIN:

The sewer capacity in the Millyard is adequately sized to accommodate future development that would produce similar wastewater volumes to those seen when the mills were in active use.

The storm water drain system in the Millyard appears to be adequate. We are currently reviewing the dye testing report performed for the Town to confirm connectivity of the site storm water features in the Millyard.

ELECTRICAL:
Currently, the Millyard and in particular the riverwalk area contain above ground electrical power lines. Upon speaking with Central Maine Power (CMP), there does not appear to be any upgrades scheduled in this area in the foreseeable future. In two to three years, there is an electrical upgrade/extension planned for Lebanon, Maine. The extension will originate out of Butler's Corner in Sanford.

The existing subsections that feed the Millyard are named 112A and 114A. The available power through these subsections is currently 34 kilovolts. This is the lowest power run through their trunk lines. In comparison, 115 kilovolts and 344 kilovolts are the other transmission capacities that are operated through their trunk lines.

According to CMP, it is very expensive to lower above ground power lines into underground conduits. As it pertains to the riverwalk, CMP might consider a scenario that has above ground wires on either end of the river walk and below ground wiring along the river walk a lightning trap. However, having this work performed is not inconceivable. The City of Portland did request and have this type of work performed for the Olde Port area of the City. We currently are requesting the engineering department of CMP provide a budgetary cost to conduct this work at the proposed river walk.

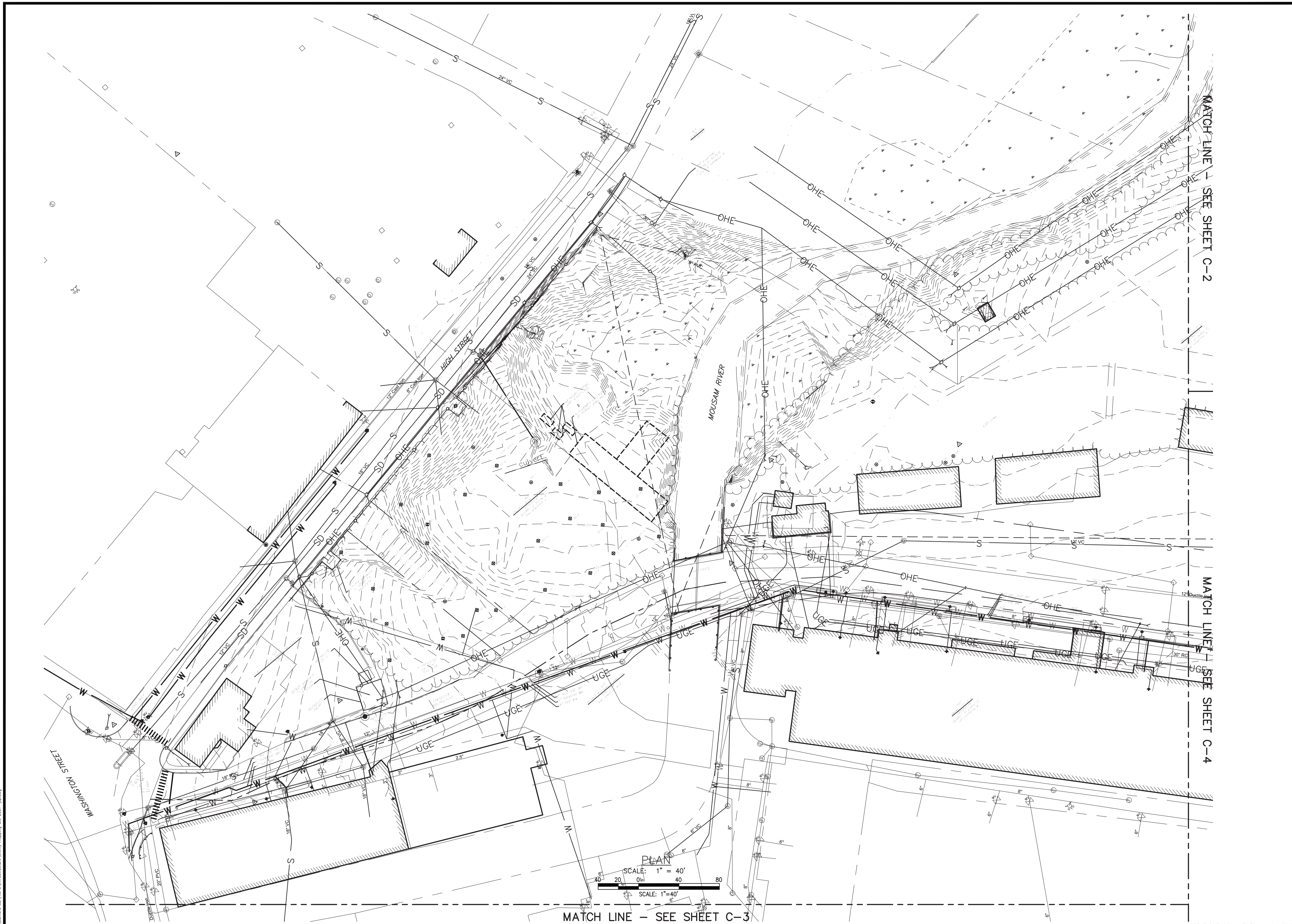
STRUCTURAL ASSESSMENT OF WALLS ALONG PIONEER AVENUE:
An assessment was done to inspect the condition of the sidewalk and retaining wall along Pioneer Avenue. The sidewalk seems to be in good condition with some minor concrete losses at the corners. The sidewalk seems to be reinforced with steel rebar with one edge set up on top of the wall without any in-fill. The side of the street closest to the sidewalk seems to be in good condition too.

The retaining wall is a concrete piers system with recessed stone infill (double check mortar). The concrete in the piers seems to be in good condition. Overall, from the street, the retaining wall seems to be in good condition.

CUTTING/CAPPING/ABANDONING UTILITIES FOR FUTURE DEVELOPMENT:
Any utility work that is performed should be coordinated with paving schedules for the roads in the Millyard. Should water or sewer services be added or improved, those services should be brought to the property line, capped and properly documented to enable relocation of the end

of the service. Capping at the property line creates the least amount of disturbance to surface features located on public property.

HOT PHOTOS OF INFRASTRUCTURE



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DEPARTMENT OR DIVISION
PROJECT TITLE

SCALE:	CONTRACT:	JOB NO.	DR.BY	DSN.BY	CHK.BY	APP.BY
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FILE NO. –

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DEPARTMENT OR DIVISION

PROJECT TITLE

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FILE NO. –

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PLAN
SCALE: 1" = 40'

40 20 0 40 80
SCALE: 1"=40'

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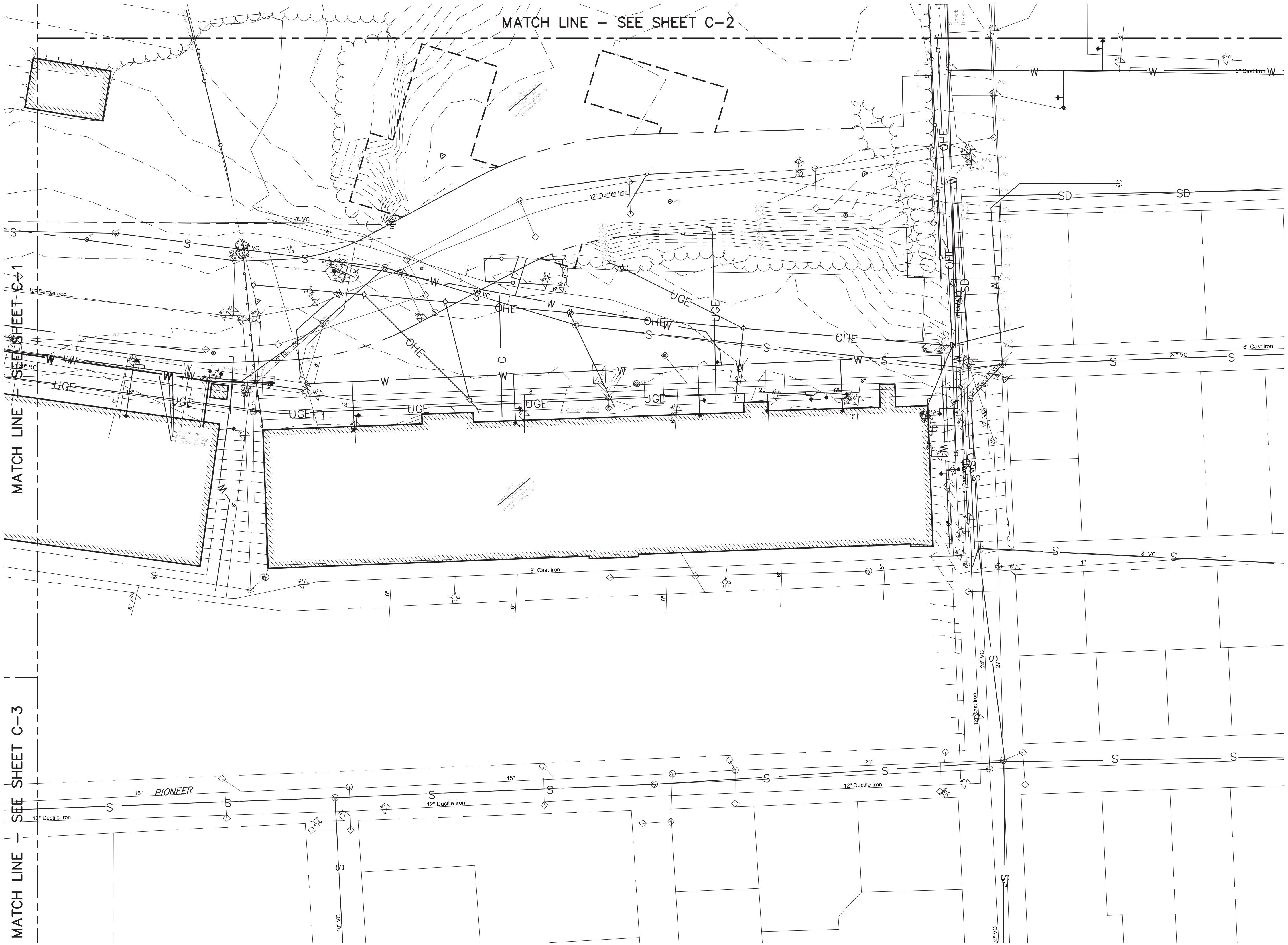

PLAN
SCALE: 1" = 40'

40 20 0 40 80
SCALE: 1"=40'

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REGISTERED PROFESSIONAL ENGINEER

DATE

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DEPARTMENT OR DIVISION
PROJECT TITLE

APP.BY	CHK.BY	DSN.BY	DR.BY	JOB NO.	CONTRACT:	SCALE:	CADD NO.	FILE NO.
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C-4

SHEET – OF –

EXISTING SEWER SYSTEM DIAGRAM

DATE: 12.29.2011

EXISTING DRAIN SYSTEM DIAGRAM

DATE: 12.29.2011

EXISTING WATER SYSTEM DIAGRAM

DATE: 12.29.2011

EXISTING
PENSTOCK
SYSTEM
DIAGRAM

DATE: 12.29.2011

SECTION 3

COMMUNITY

3. RENEWABLE ENERGY

HARNESS THE SITE'S LATENT ENERGIES:

The Sanford Millyard and the land adjacent to the Mousam River offer exciting opportunities to harness, capture, and store the site's natural energies. Renewable energy technologies of today include wind, solar, geothermal, bio-energy, hydropower, tidal/wave or ocean, and hydro power. For the purposes of the Millyard, **geothermal and solar power** offer the most potential to decrease reliance on traditional fossil fuel sources and to assist in rebranding the site from a contaminated place to a sustainable destination.

GEOTHERMAL:

A Geothermal Heat Pump (GHP) system is a heating and cooling system that takes advantage of **heat stored in the ground**. The system uses the stability of underground temperatures to extract heat in the winter to warm spaces and cool building temperatures in the summer. A GHP system does not have aesthetic impacts. The infrastructure is below-grade and can be integrated with the landscape architecture of the site with minimal modifications. There are **no adverse environmental impacts** in a properly designed and installed GHP system. However the investment for installation costs of the infrastructure is substantial. Depending on the size of the system and number of buildings served, the payback period could range anywhere from 7 to 25 years. Geothermal energy systems have been successfully incorporated into recent construction projects elsewhere in Sanford in recent years.

SOLAR:

Solar photovoltaic (PV) systems require unshaded or **open areas on roofs or on the ground**, preferably with southern exposure. Solar resources for Sanford are moderate, although most mill buildings have large, flat, south-facing rooftop surfaces, which lend themselves well to solar arrays. There are also large areas on the ground adjacent to the Millyard where a solar array could be installed. While historically ground-mounted PV arrays have been fenced and preclude public access, new developments in solar panel mounting technologies allow for the public occupation of the open space beneath the panels. The payback period of a solar application ranges from 16-26 years.

WIND:

There are a number of scales at which wind energy is currently being developed. The Millyard's proximity to the downtown and water resources coupled with our initial analysis of wind exposure in the Millyard indicate that smaller microwind turbines may offer a tolerable payback period, but that large turbines are not feasible nor advisable at this site.

Public outreach conducted to inform re-use planning has included:

8.16.11 — *Kick-off Meeting* at Mousam View Conference Center
EPA staff in attendance, Audience Response System (ARS) used for real-time participatory feedback (attached).

9.27.11 — *Sanford Regional Growth Council monthly meeting* at Town Hall
Weston & Sampson presented initial findings for urban design schematics and received feedback from the Council.

10.5.11 — *Airport Market Report Findings Presentation* at Springvale Theater
AWPG Team attended airport consultant presentation on the findings of the marketing report and proposed potential rebranding strategies for Sanford. A key take-away was making Sanford a gateway for the coastal community to fly into Maine and head east.

12.2.11 — *Presentation at "Holly Daze" Festival* at Fabulous Formals Storefront
Millyard Planning Open House (after Holiday Parade and tree lighting) where over 200 residents and visitors stopped in to listen to a presentation made by Letitia Tormay of Weston & Sampson on potential re-use scenarios for the Millyard, view the model made by the high school students, and have some Shane's of Maine ice cream. A handout with polling questions was distributed to all attendees and those have been returned to Town Hall over the last few weeks. Comments are summarized and attached to this report.

12.6.11 — *Presentation to Students* at Sanford High School Library
40 students from the Regional Technical Center and Sanford High School attended. Participation was encouraged through the use of ARS, collaborative brainstorming and voting.

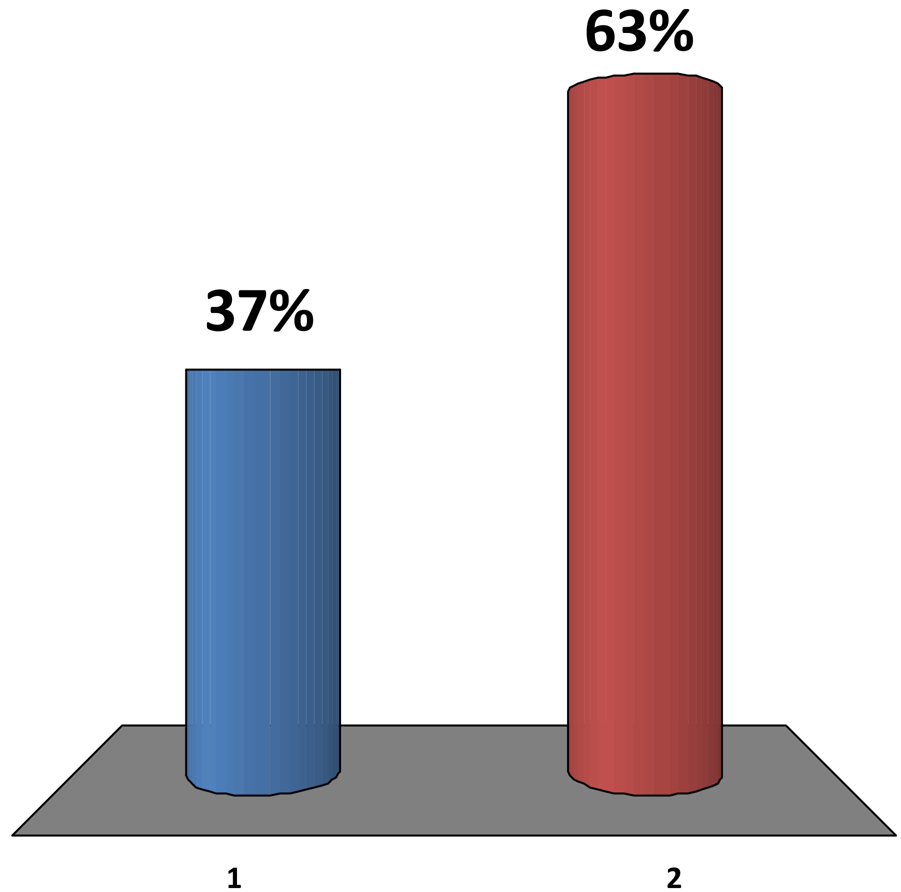
Public Input Gathered at the August 16th, 2011 Kick-Off Meeting


SANFORD,
MAINE
Brownfields Area-wide Planning
Pilot Program
Kick-off Workshop
August 16, 2011 Q+A


IMPLEMENTATION

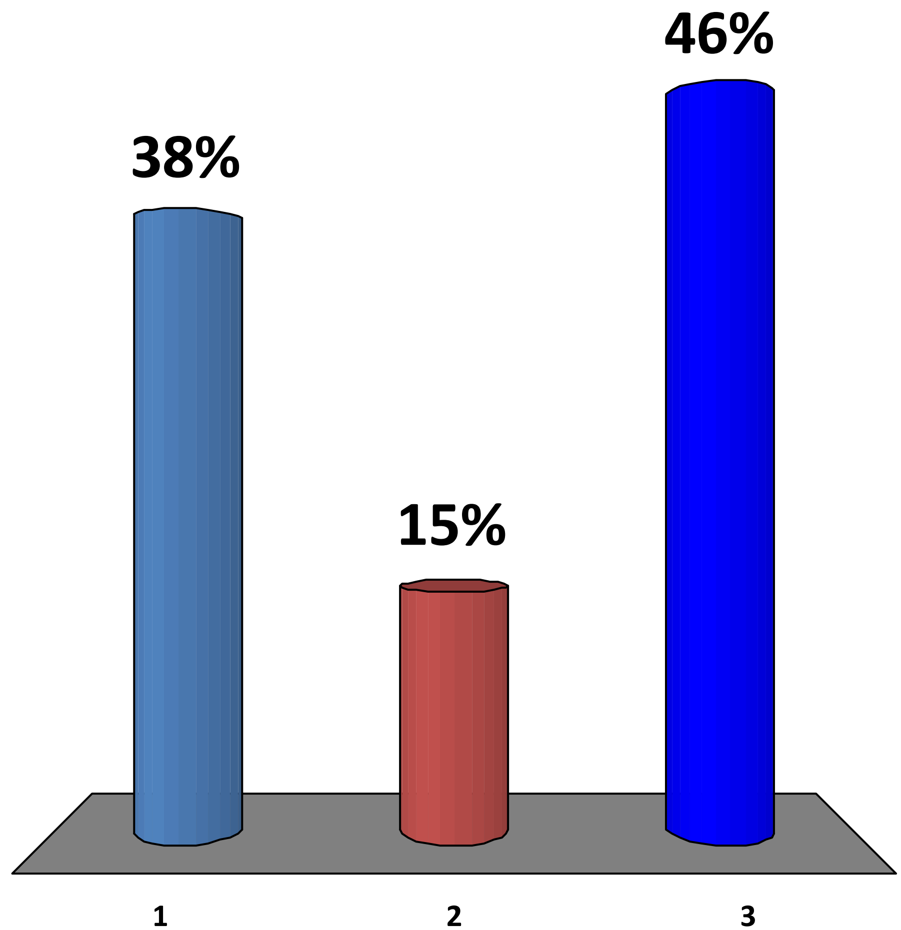
I have used this means of public participation/engagement in the past?

1. Yes
2. No



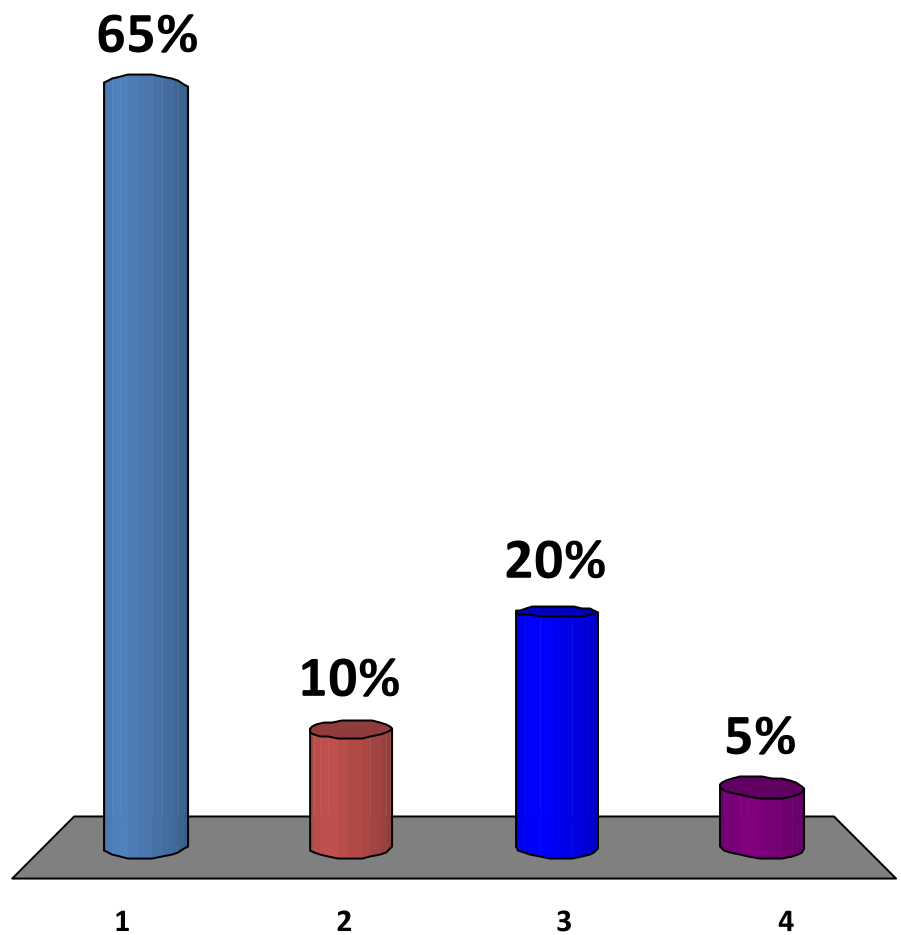
I am from?

1. Sanford
2. York County
3. Elsewhere



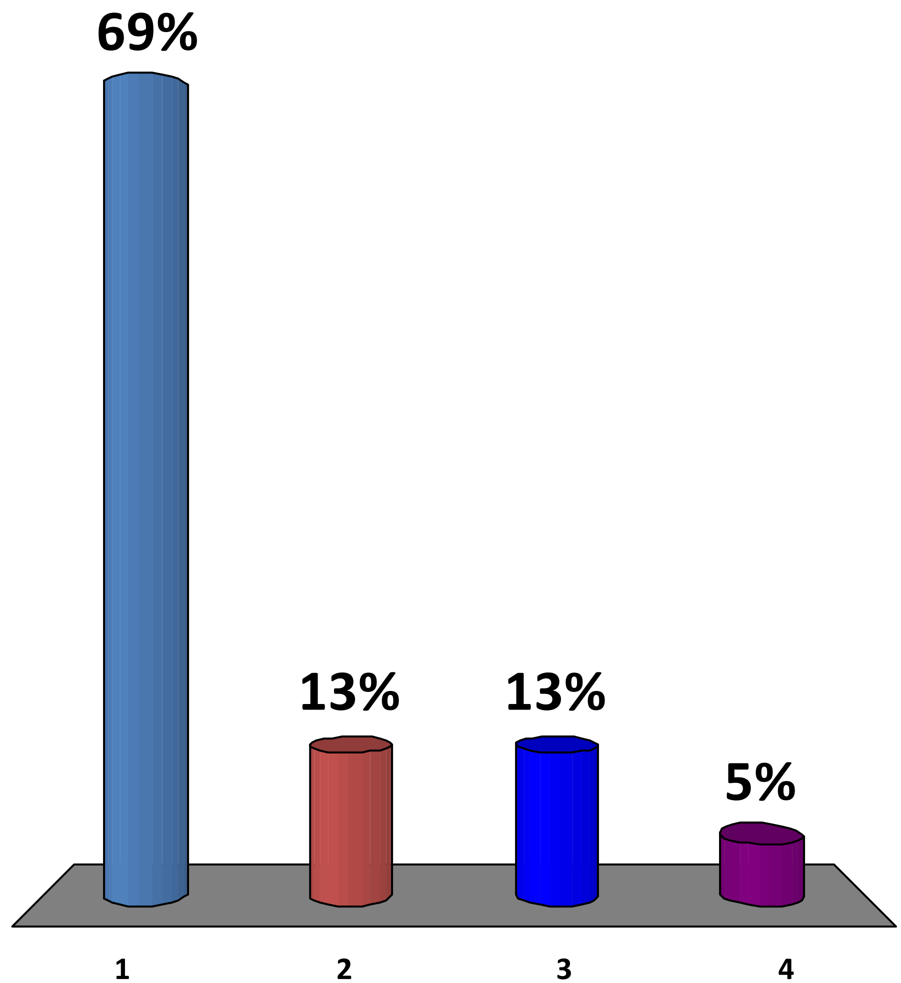
The best team is baseball is?

1. Boston Red Sox
2. New York Yankees
3. Sanford Mainers
4. Other



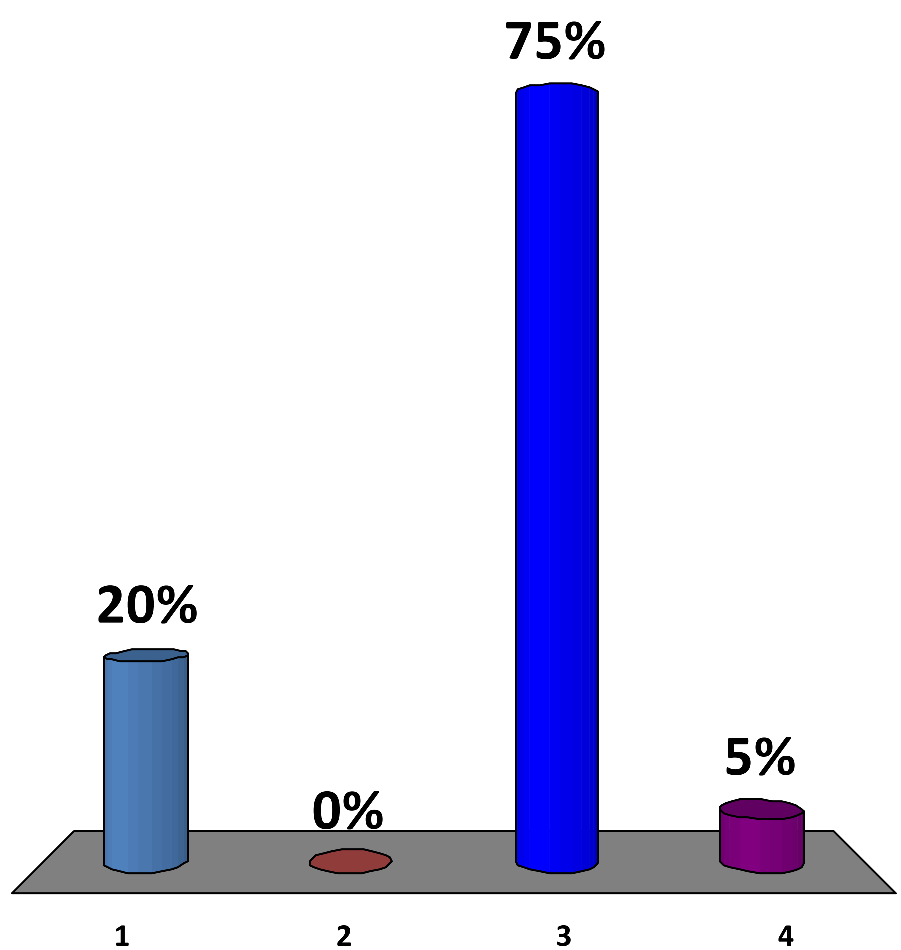
Maine is best known for?

1. Lobsters
2. Lighthouses
3. Moose
4. Romantic getaways



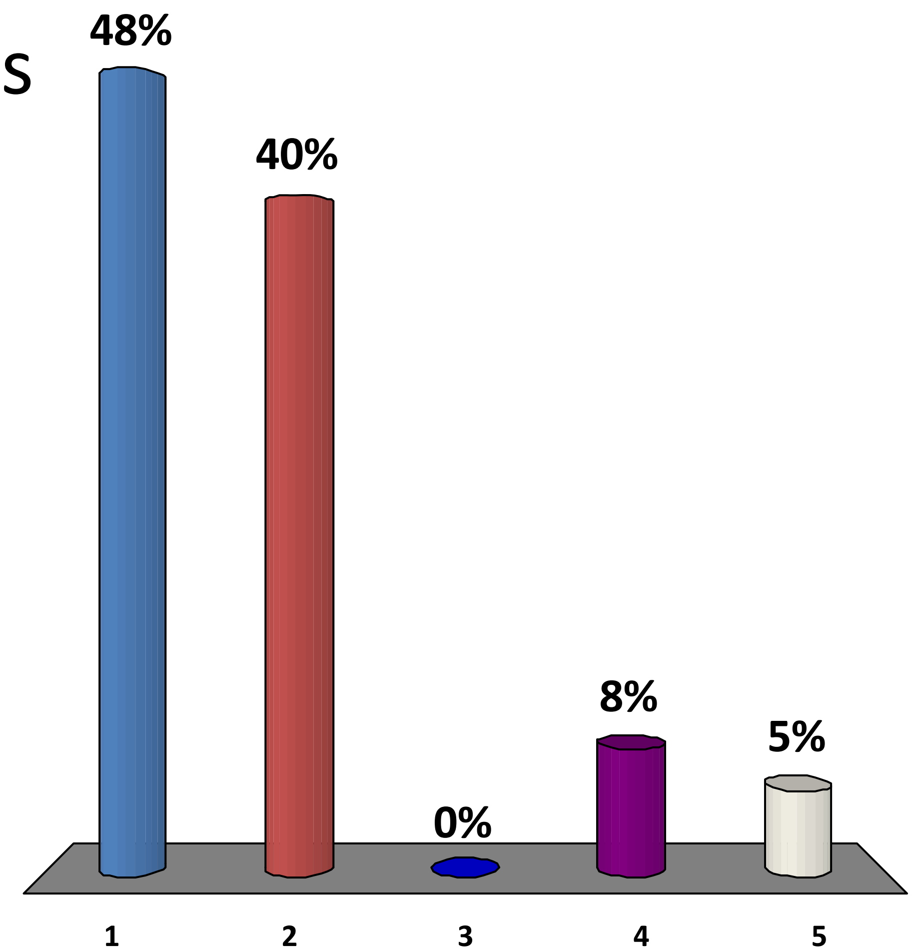
What does an **Area Wide Plan** mean to you?

1. An opportunity to tie planning initiatives together
2. A fresh look at planning priorities
3. Develop a meaningful implementation plan for Sanford
4. Other



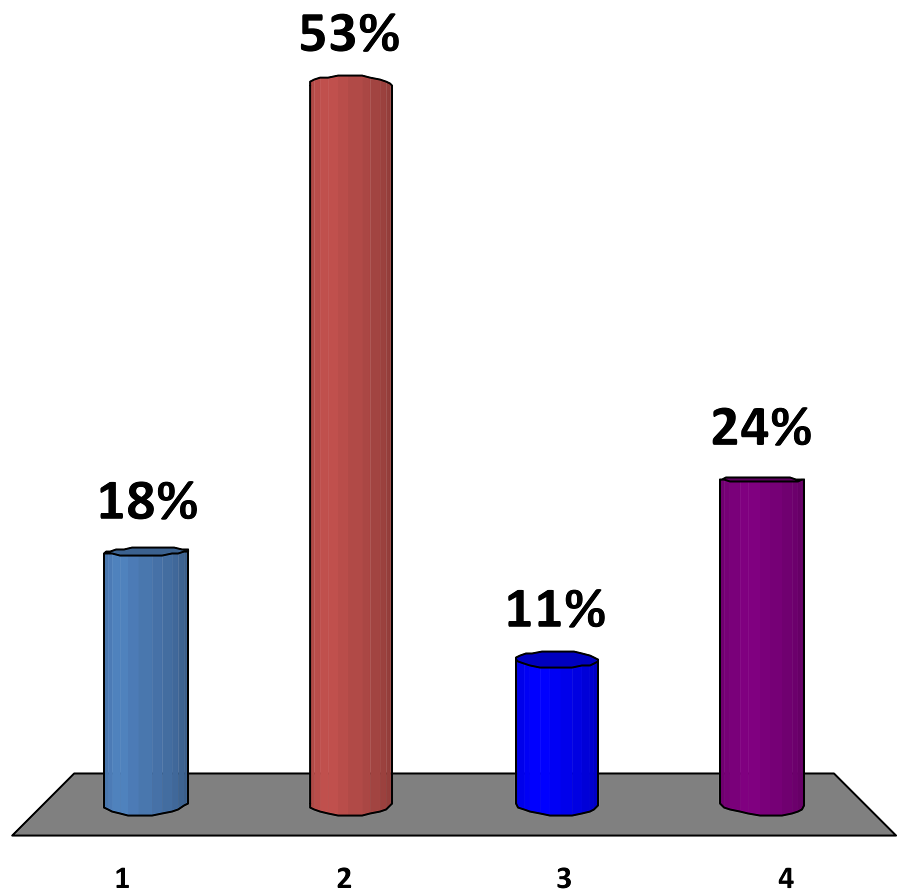
With a focus on the Millyard, what is **most important** to you?

1. Reuse existing buildings
2. Stronger connections to the downtown
3. Improved traffic flow
4. Open space and public access to the Mousam River
5. Other



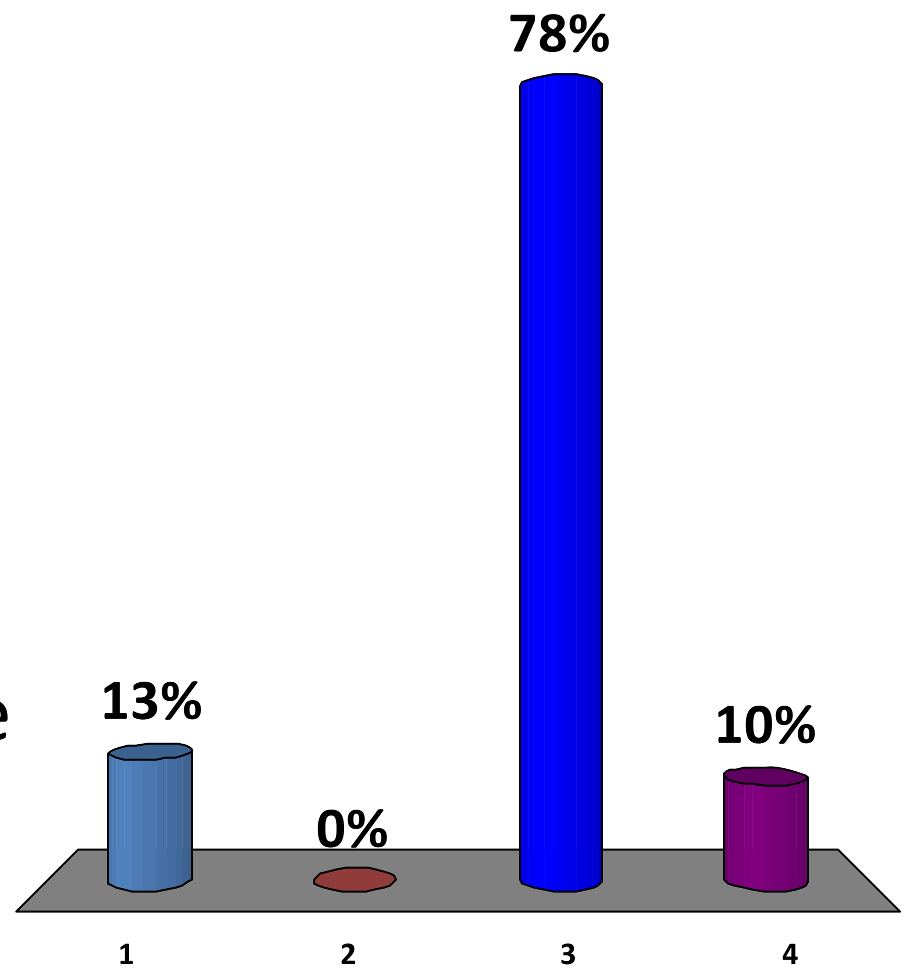
How should we measure **short-term** success?

1. It leads to future funding
2. It helps to change the image of the place
3. Increase in tax base and employment
4. A number of sites are no longer contaminated



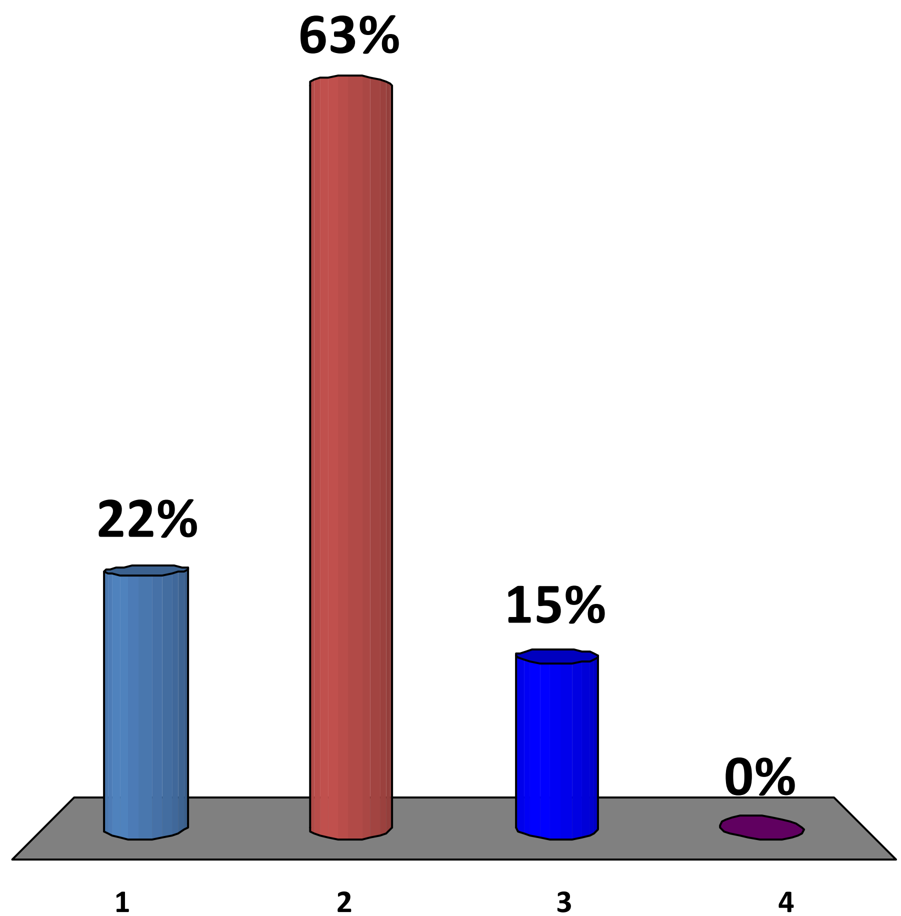
How should we measure **long-term** success?

1. It is implementable
2. It results in an inclusive process
3. The work is a catalyst for future development
4. All brownfield sites are remediated



How much **public engagement** is appropriate?

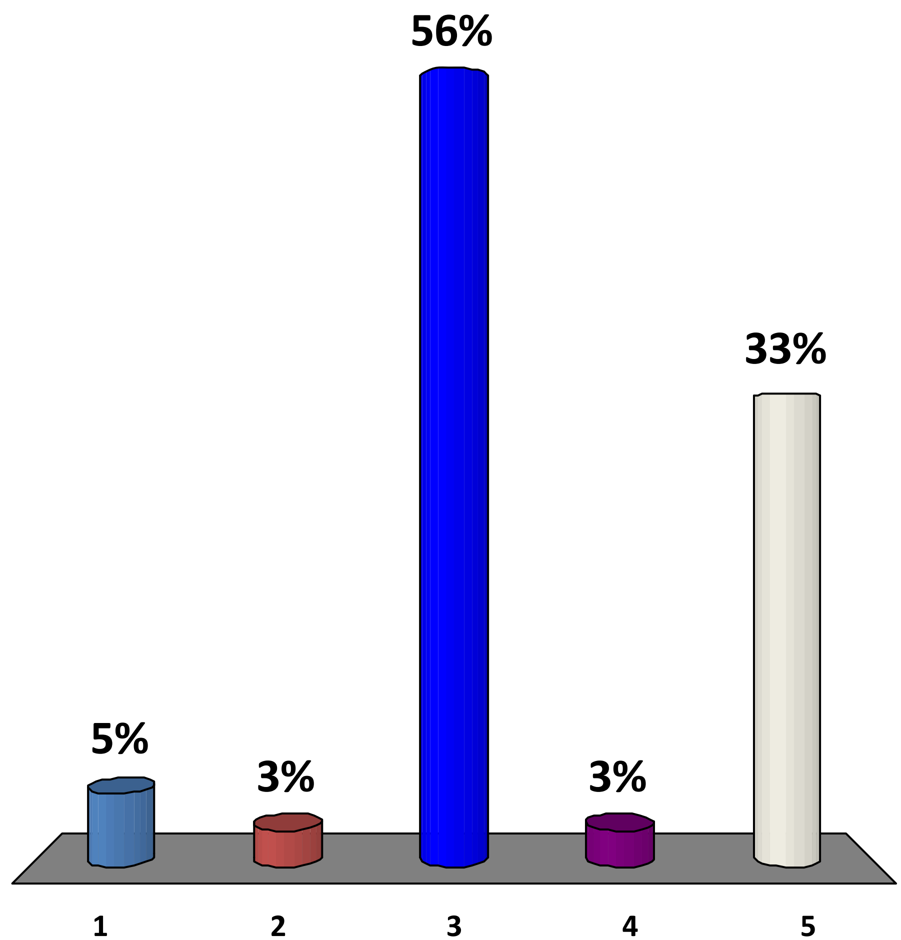
1. A lot: multiple community forums
2. Some: strategic engagement
3. Very little: focus time on implementation
4. None: synthesize what has been done



ECONOMIC DEVELOPMENT

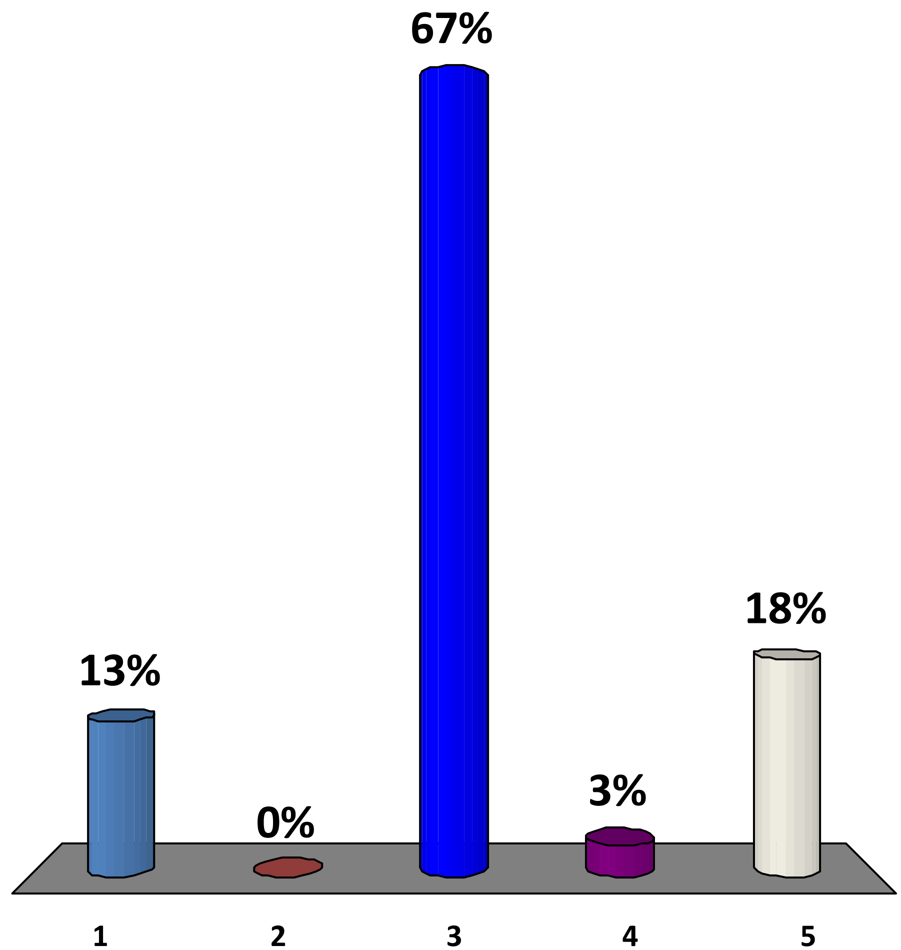
What are the **competitive advantages** for the Mill Yard?

1. Skilled workforce
2. Airport access
3. Inexpensive land facility costs
4. Energy
5. Other



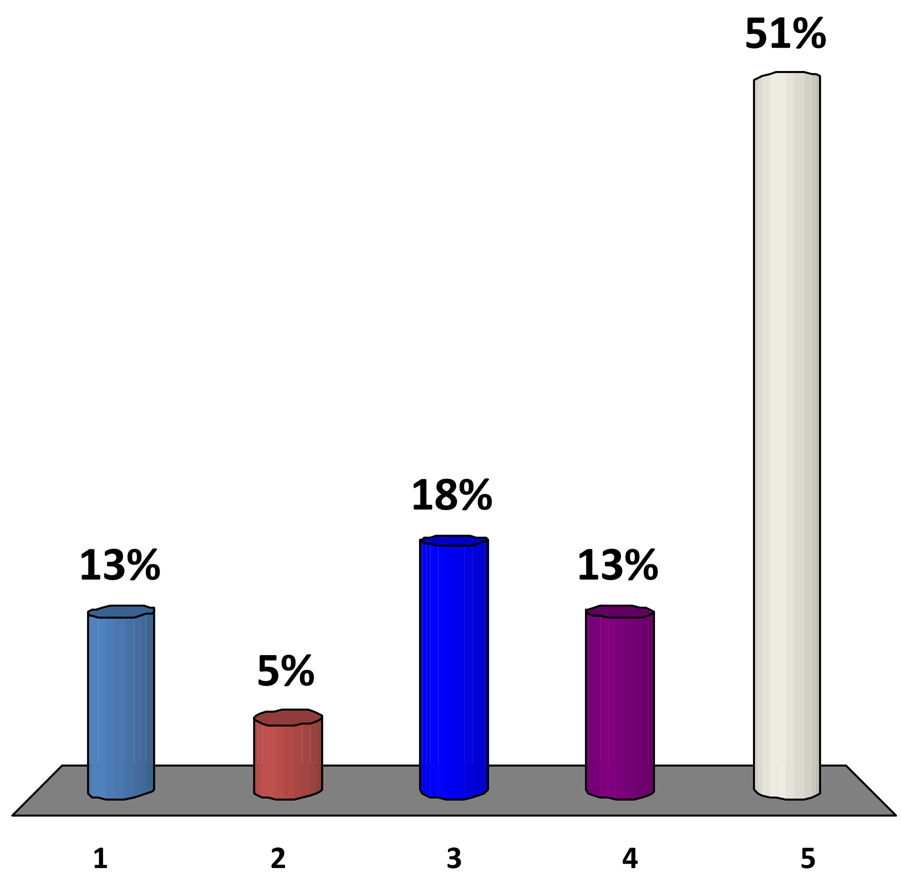
What do you feel are the **most likely reuses** for the Mill Yard?

1. Mostly residential
2. Mostly industrial
3. A mix of residential and industrial
4. Arts, culture and academic space
5. Other



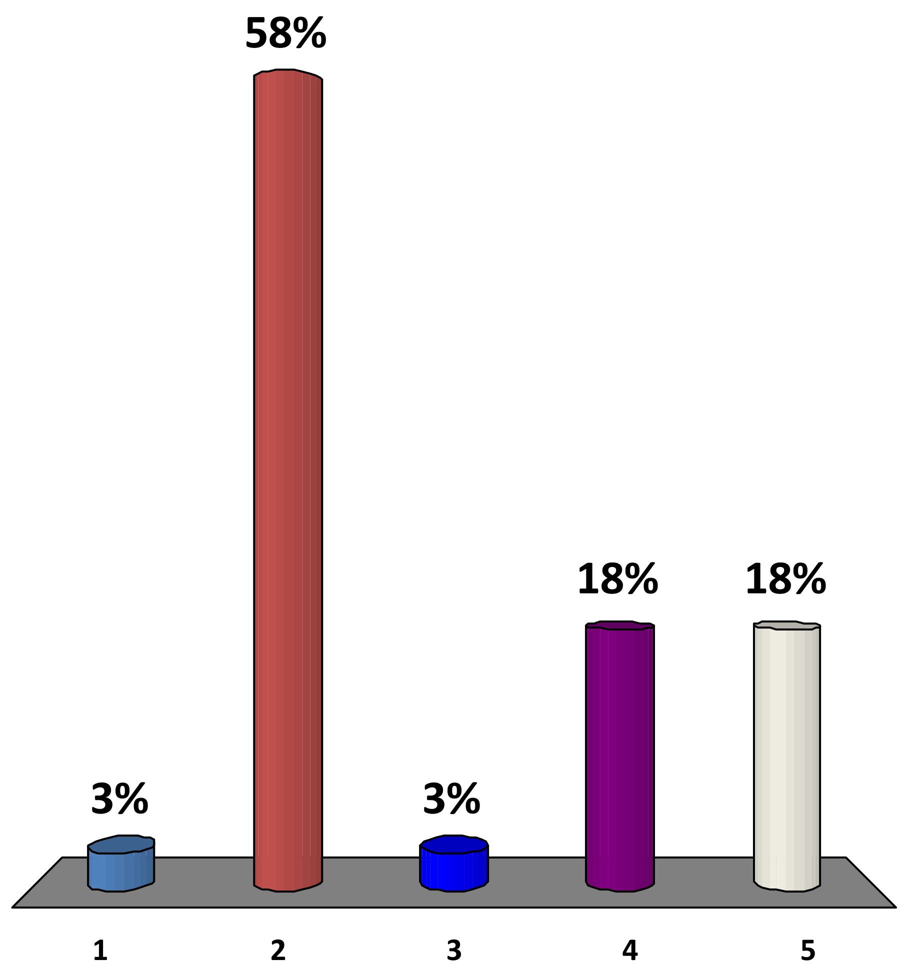
If there is a market for **industrial uses**, which ones should be sought?

1. High-tech
2. Locally-based companies
3. Vocational (Vo-tech) training
4. Anything possible
5. All of the above



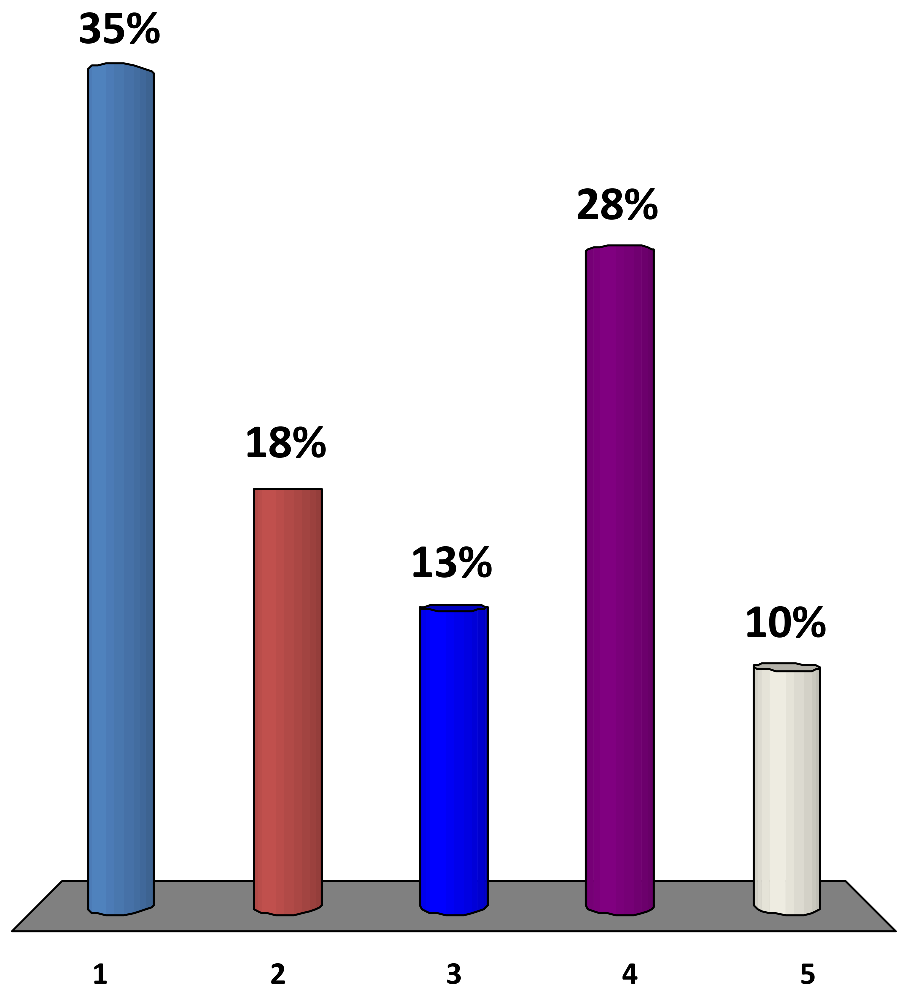
If there is a market for "**artisan**" **food production**, which ones?

1. Coffee roasters
2. Brewery
3. Chocolate making
4. Hydroponic farming
5. Commercial bakery



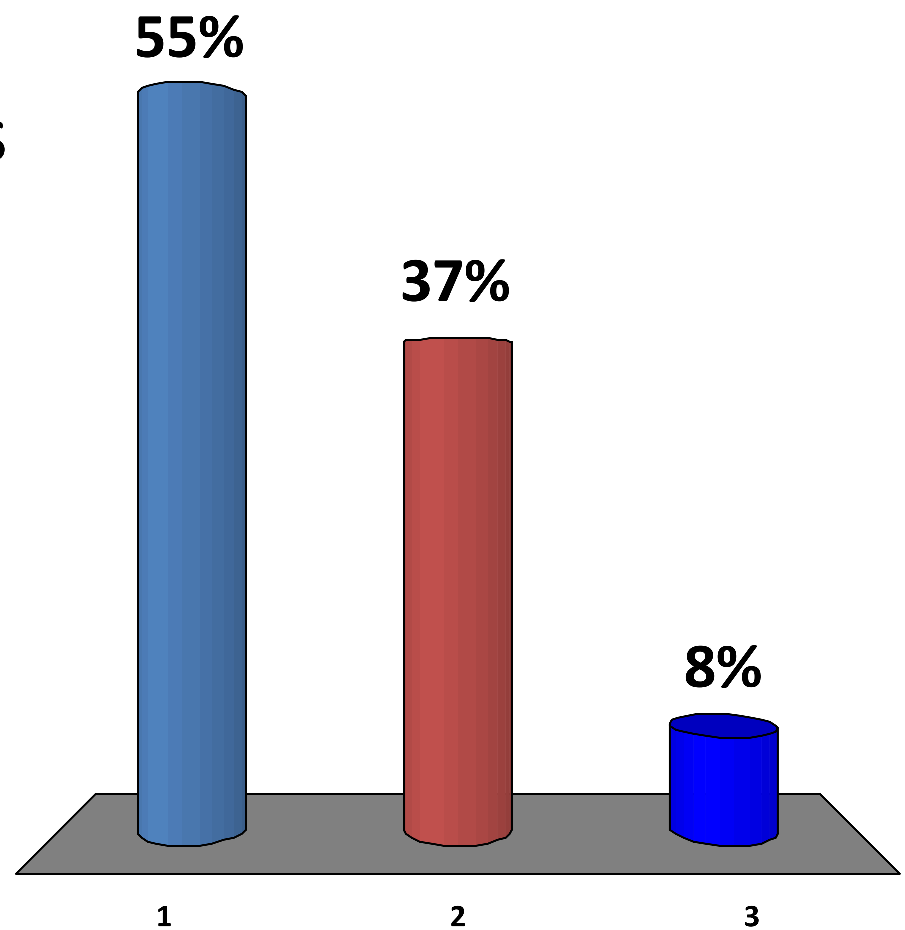
If there is a market for **cultural programming,** which ones?

1. Theater/performance
2. Museum(s)
3. Textile artist studios
4. Indoor playground / rock climbing gym
5. Other



How should we address the Mill Yard's **historic character**?

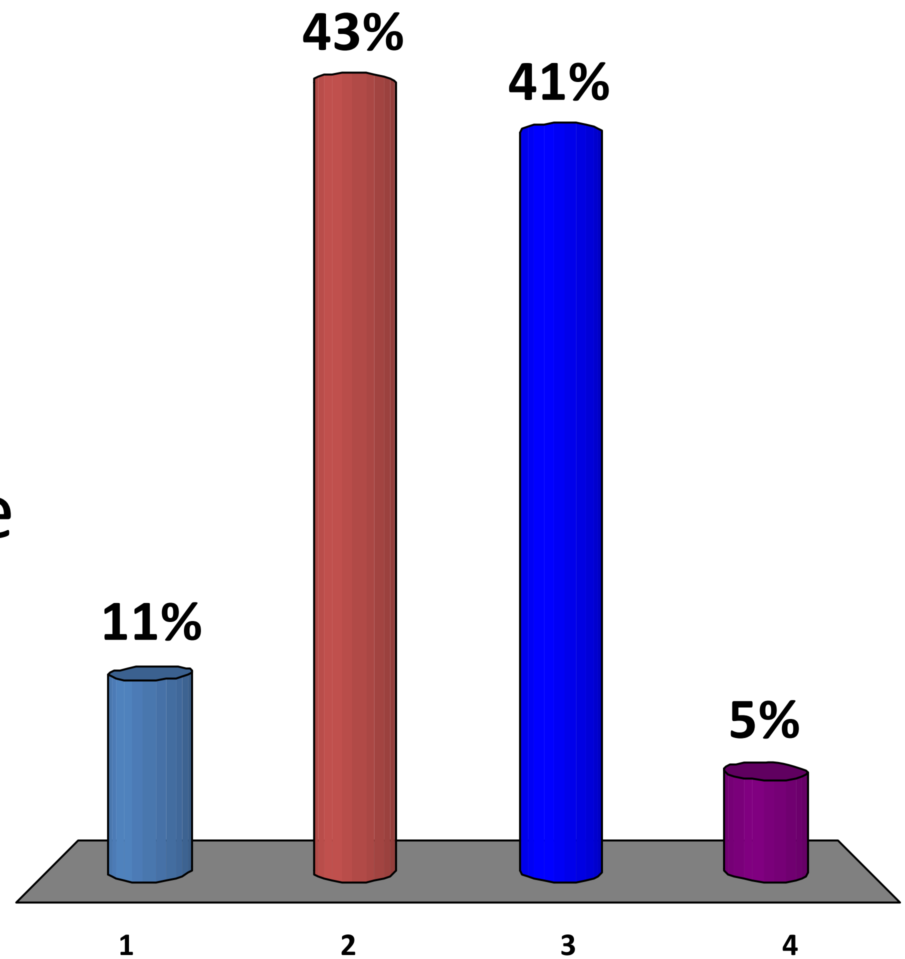
1. Preserve and reuse as much of the complex as possible
2. Demolish only the most dilapidated
3. Clear as many of the buildings as possible




OPEN SPACE

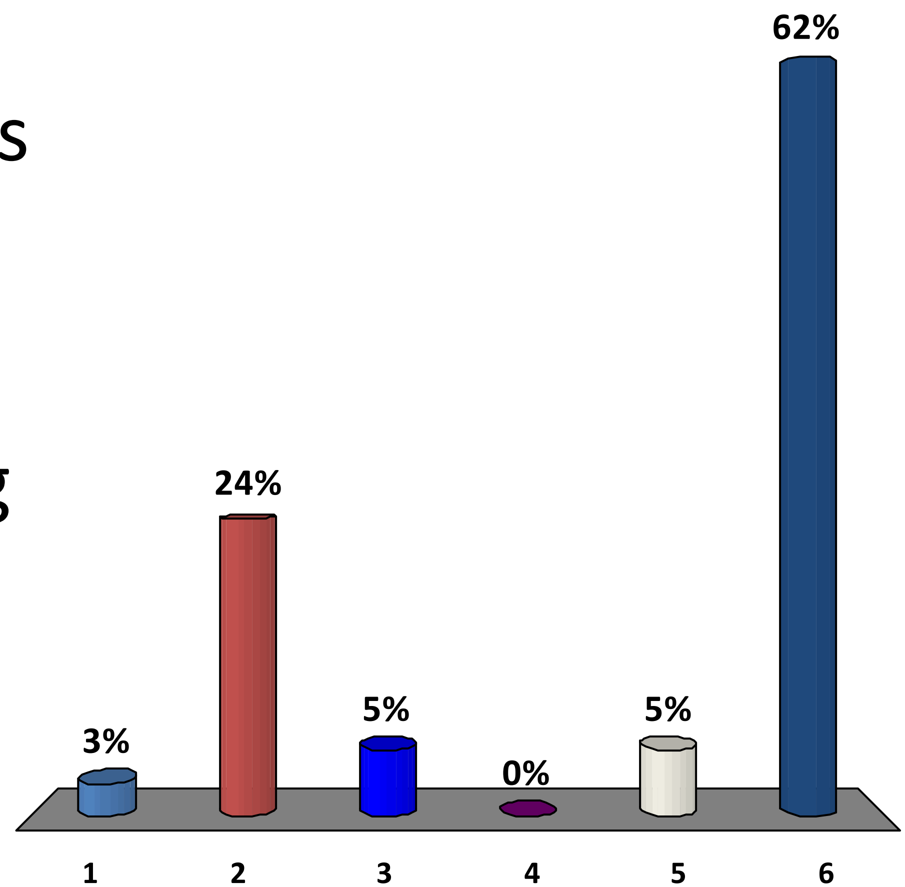
What is an appropriate character for the Mill Yard's **open space**?

1. Village-like setting
2. Extension of downtown
3. A unique, campus-like environment
4. Other (TBD)



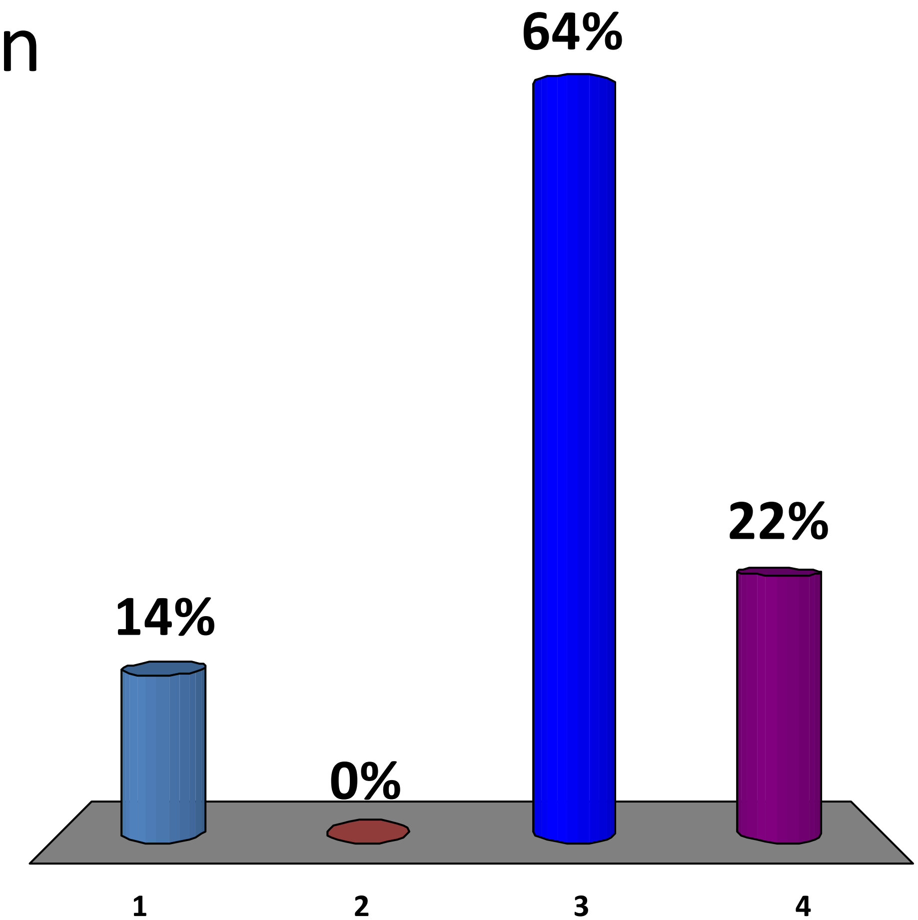
What are appropriate uses for **Number One Pond and Mousam River**?

1. View from afar
2. Walking trails at edges
3. Non-motorized boat access (canoe/kayak)
4. Swimming and fishing
5. Power generation
6. All of the above



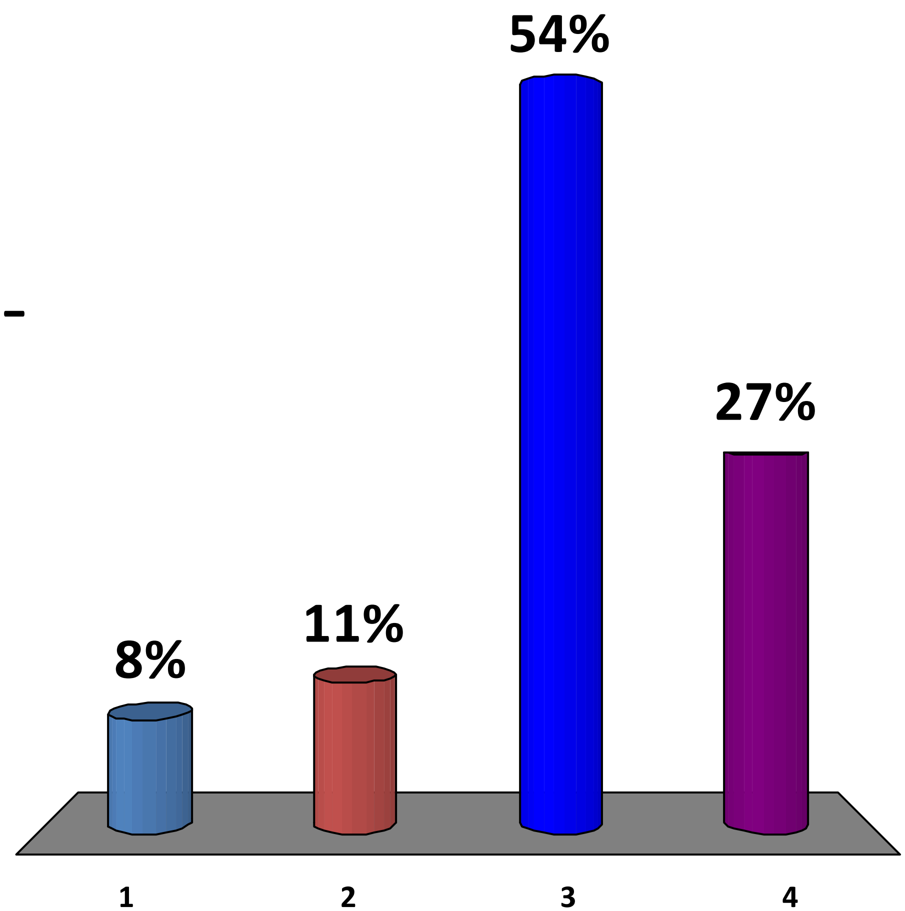
How should one accommodate the potential **parking demand**?

1. As much as possible in structured parking
2. All surface parking
3. A mix of on-street, surface and structured
4. Strive to reduce auto dependency



What is the **appropriate relationship** between the Mill Yard and downtown?

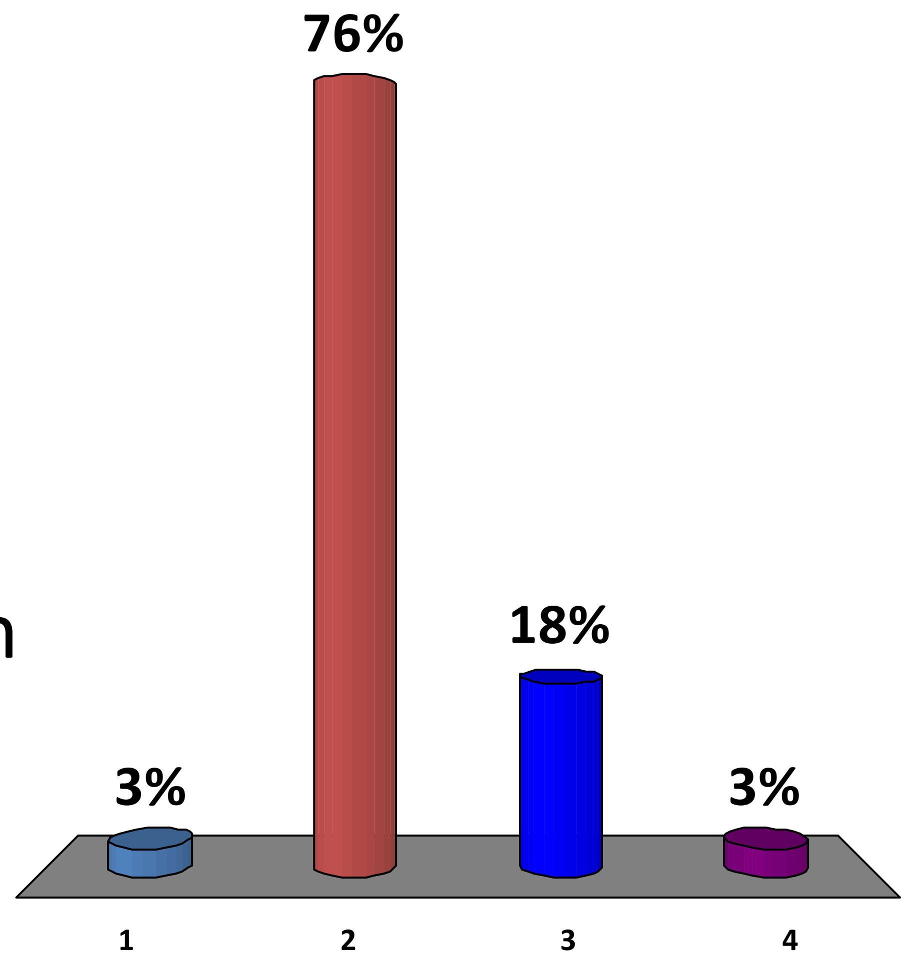
1. The Mill Yard is a distinct district
2. Invest in the streets in-between them
3. Integrate the two
4. All of the above




ENVIRONMENT

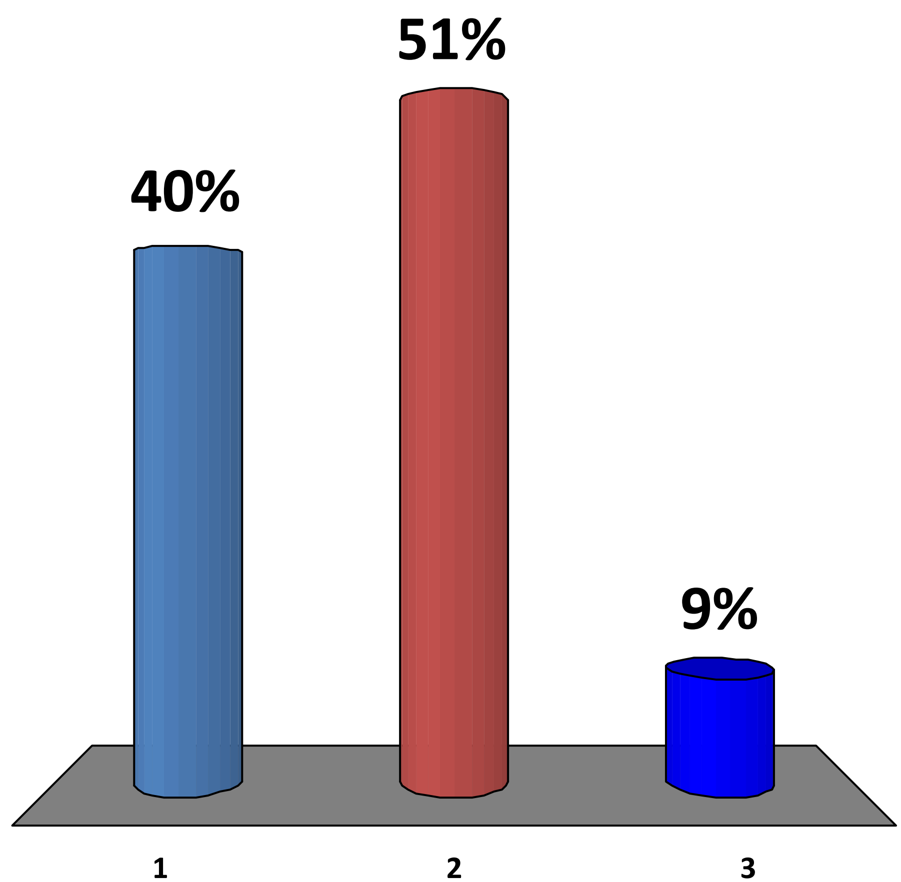
Which **brownfield sites** should be addressed first?

1. The most contaminated
2. Focus on those sites most likely to be rehabilitated
3. Remediate all of them as soon as possible
4. Other



Should the Town invest in **cleaning up** Number One Pond and the Mousam River for more **active use**?

1. Yes, it should be a priority
2. Yes, if funding is available
3. No



ENERGY AND INFRASTRUCTURE


SANFORD, MAINE
THANK YOU!
Brownfields Area-wide Planning
Pilot Program
Kick-off Workshop
August 16, 2011 Q+A

- Relationships / Political Will
- Portland / Boston Market Proximity
- Leadership
- Labor Base
- Fed/State/Resources
- IDC Facilities near airport
- Manufacturing — competitive with any Maine Region
  (Fisher – 20 employees)
- Quality of Life — Urban — place together

Needs

- + Demand ?
- + Regional Market ?
- I-95 ?
- + Connection
- + streamlined development process
- + Mkt. Issue research

ECONOMIC DEVELOPMENT

Better/ improved access

MARKET NEW IMAGE FOR SANFORD

Expanded HS / YCCC Targeted Training

MARKET THE ATTRIBUTES OF THE SANFORD REGION!!

Focus on differentiation of Sanford through single industrial cluster development.

Create a strong vision that promotes & preserves our urban "Quality of Life"

Clean up corridors to make image change. -

Center for mfr excellence – have the workforce to handle growth

TECHNICAL VOCATIONAL CENTER (EAGLE DRIVE)

Self Fulfilling Prophecy ⇒ marketing its assets ↓ direction of growth

VOCATIONAL CENTER IN THE MILL YARD

IDEAS

- Natural Gas
- Vocational Center
- Match - Education/Skill w/others w/same Skills
  out of date
- Incubator space ⇒ grow businesses

- New Market, NH (not off tipping)
- Portsmouth (Mkt. St.)
- Dover
- Portland
- Bath, Maine
- Lewiston / Auburn

Sanford Holly Daze

Kick Off Events, Friday December 2, 2011
4:00pm – 7:30pm

4:00 pm – 7:00 pm
Holiday Open House Cider & Cookies, Sanford-Springvale Art Association, 917 Main St., Downtown Sanford

4:00 pm – 8:00 pm
Holly Village Shops Grand Opening at the former Kennebunk Savings Bank, 883 Main St., Downtown Sanford

5:30 pm
Annual Holly Daze Parade & Santa's Arrival, Parade begins at Dairy Queen on Main St. and ends at Mid-Town Mall.
Garnsey Brothers @ 909 Main Street, serving Hot Cocoa
Following the Parade
Lighting of the Christmas Tree at Central Park
SRTC Poinsettia Sale to benefit SRTC Landscape & Horticulture Program
Millyard Redevelopment Open House hosted by Sanford Regional Economic Growth Council. Doors open at 5:30, with presentation and refreshments immediately after the tree-lighting, 907 Main St., Downtown Sanford

7:15 pm – 8:00 pm
Free Zumba Tonic Dance Class, recommended for kids ages 5-10. Northern Explosion Dance Studio, Mid Town Mall, Downtown Sanford

7:30 pm
Dickens' A Christmas Carol, Sanford Maine Stage, Nasson Community Center, 457 Main Street, Springvale

Sanford Regional
ECONOMIC GROWTH COUNCIL

Millyard Redevelopment Open House Feedback!
Please return to SREGC, 917 Main St., Sanford ME 04073

What do you feel are the most likely reuses for the Millyard?
1. Housing 4
2. Industrial 2
3. A mix of residential and industrial space 9
4. Arts, culture and academic space 9
5. Other: *Sm Biz, Com Off, Inside out Playground- like Waterville, ME*

With a focus on the Millyard, what is most important to you?
1. Reuse existing buildings 10
2. Stronger connections to the downtown 8
3. Open space and access to the Mousam River 3
4. Other: M*ore stores*

How should we address the Millyard's historic character?
1. Preserve and reuse as much of the complex as possible 7
2. Demolish only the most dilapidated 6
3. Remove as many of the buildings as possible 2
Fix windows

What is an appropriate character for the Millyard's open space?
1. Village-like setting 4
2. Extension of downtown 9
3. A unique, campus-like environment 2
4. Other: *City setting*

How should one accommodate the potential parking demand?
1. Structured parking 6
2. All surface parking 0
3. A mix of on-street, surface and structured parking 6
4. Strive to reduce auto dependency 4

Additional information will be posted at www.sanfordgrowth.com

economic development, workforce development, business finance and tax incentive matters. Mr. Nimon is a graduate of the University of Maine with a degree in political science and resides in Springvale.

Millyard Open House Presentation ~ **Letitia Tormay, RLA Landscape Architecure, Weston & Sampson, Peabody, MA**

Letitia Tormay is a Landscape Architect with Weston & Sampson in Peabody Massachusetts. She brings to the table 15 years of design experience working with award winning firms in the Boston area. She has worked on several innovative mill restorations including; Museum Lewiston/Auburn in Maine, Wood Mill in Lawrence Massachusetts and Boot Mill in Lowell Massachusetts. She began her career working in Saco Maine and living in Portland for far too short a time and gets back to Maine any chance she gets. She is the lead designer for the open space portion of the project which focuses on knitting together all the exterior spaces into a dynamic new outdoor experience for visitors to the future mill yard.

A Special Thank You

To The Many Millyard Redevelopment Project Participants And the Generousity of All of our Open House Sponsors

- Sanford Regional Technical Center Students
- Sanford Regional Technical Center Faculty
- WSSR~TV Studio Students and Staff
- Jeff Shain~ Shain's of Maine
- Rose Caron ~Rosa's Bakery
- David Mongeau~French Connection
- George Sleeper
- Sanford Downtown Legacy
- Weston & Sampson
- All current and future involved citizens

Sanford Regional
ECONOMIC GROWTH COUNCIL

Economic Development in the heart of York County, Maine's Southern Gateway

__The Sanford Regional Economic Growth Council__ (SREGC) is a partnership of the Town of Sanford, the Chamber of Commerce and the Industrial Development Corporation. This evolving organization is chartered to be the leading economic development organization in central York County and has embarked on an aggressive and cutting-edge strategy to increase the prosperity of its citizens and enhance the area's economy.

Sanford was first settled in 1739. Incorporated a town in 1768, it was named after Peleg Sanford. The Mousam River provided water power for industry allowing Sanford to develop into a textile manufacturing center. Products included cotton and woolen goods, carpets, shoes and lumber. Skilled textile workers were attracted to Sanford from the woolen centers of England, the French-speaking provinces of Canada, and from other foreign countries.
The Sanford Goodall Mills were the largest textile mills of their type in the world at that time.

One of the key objectives of the SREGC partners is the redevelopment of Sanford's historic Mill Yard District which was once the economic engine for this community and this region. Several exciting opportunities have recently emerged within the district including: the town's construction of a much-needed road to support and facilitate development; developers like Brady-Sullivan and the Northland Group committed to converting former mill buildings into multi-million dollar mixed-use development projects; receipt of a coveted pilot grant from the EPA to ensure achievable action steps; and receipt of an FTA grant for the Sanford Transportation Center (STC) which will serve as an intermodal hub for public transportation and intercity bus riders.

A coordinated approach to the cleanup and redevelopment of Brownfields sites will go a long way to restoring the Mill Yard's historic economic role. These activities send a powerful signal to other developers about the development potential of Brownfield sites. But all of this depends on maintaining momentum. There are still many Brownfield sites that need to be cleaned up, such as the STC site in the Mill Yard. This can be achieved with smart community planning, and continuous positive community involvement.

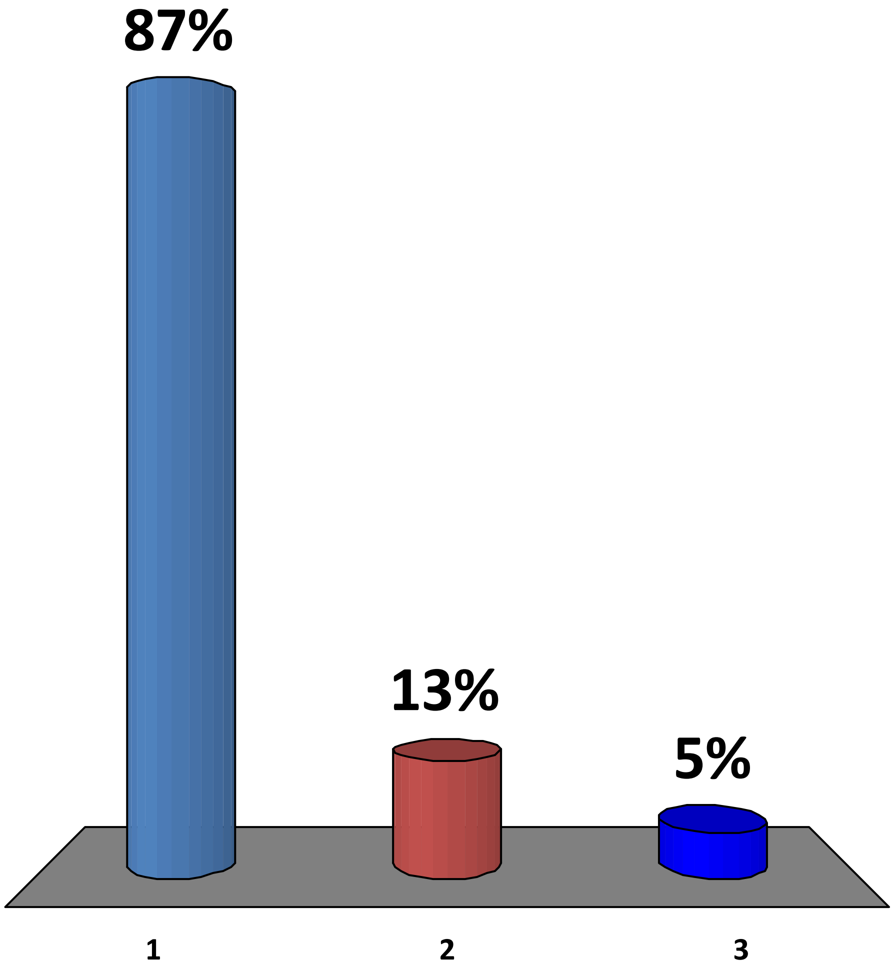
Millyard Open House Welcome~**James F. Nimon**

James F. Nimon is the Executive Director of the Sanford Regional Economic Growth Council. Prior to his appointment, Mr. Nimon served as the senior economic policy advisor to Governor John Baldacci advising the Governor on all economic development issues ranging from the redevelopment of the Brunswick Naval Air Station to the operation of the Department of Economic and Community Development (DECD). Mr. Nimon has also held senior-level posts in the last four administrations, including: program director/loan officer with the Finance Authority of Maine; workforce development director with the Maine Department of Labor; and business development/tax incentive director at DECD. These experiences have kept Mr. Nimon successfully engaged over the past thirty years with hundreds of companies and communities as they addressed


SANFORD,
MAINE
Brownfields Area-wide Planning
Pilot Program
Workshop
December 6, 2011 Q+A

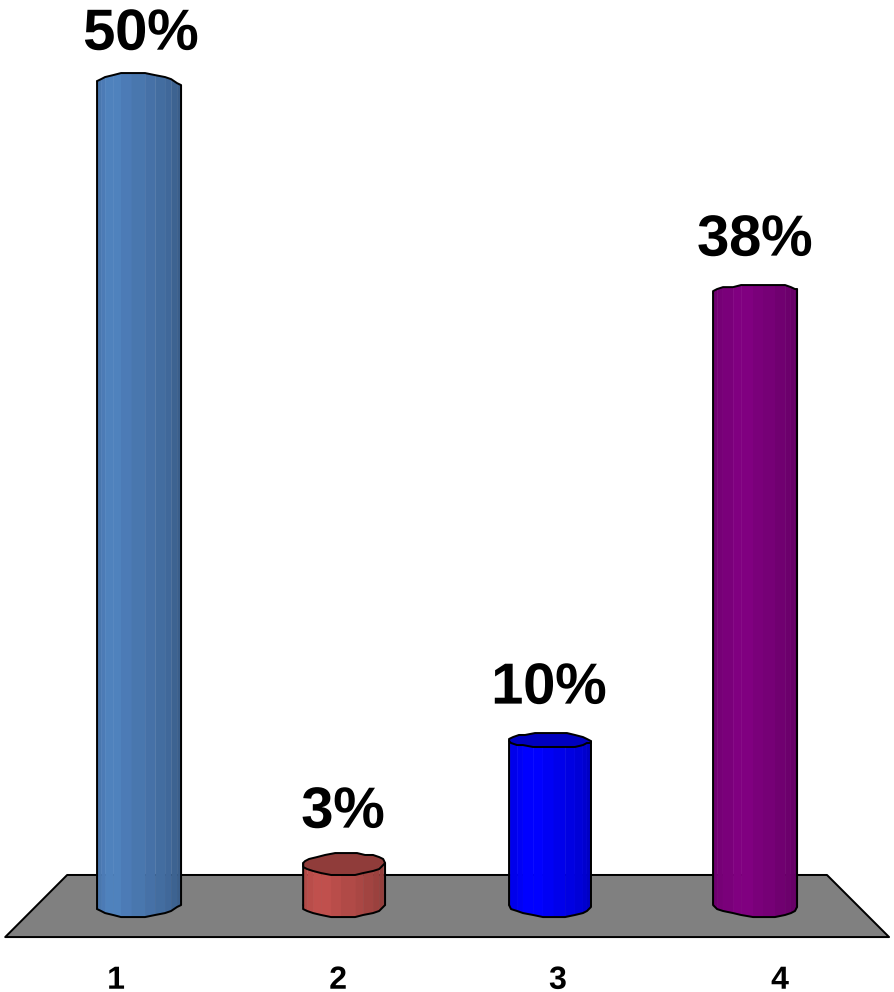
Maine is **best** known for?

1. Lobsters
2. Lighthouses
3. Moose



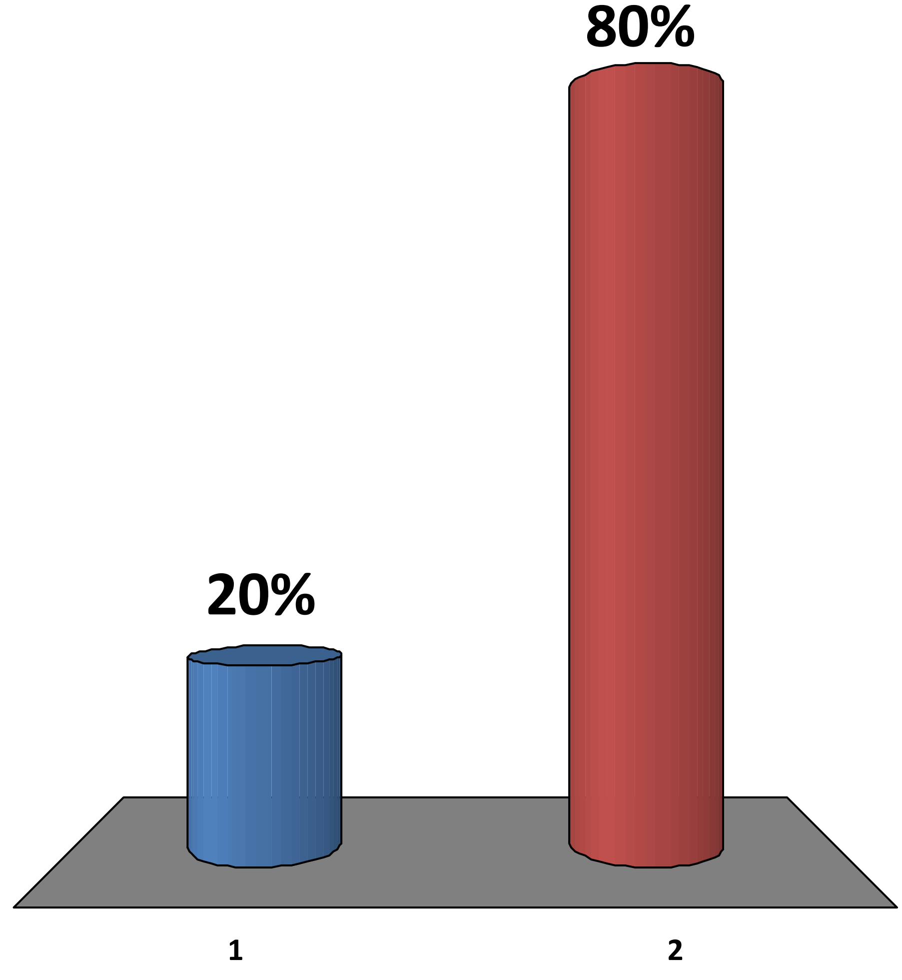
The best baseball team is

1. Boston Red Sox
2. New York Yankees
3. Sanford Mainers
4. Football is better



I have used this means of **public participation/engagement** in the classroom?

1. Yes
2. No



What do you feel are the **most viable reuses** for the Millyard?

1. Housing
2. Industrial
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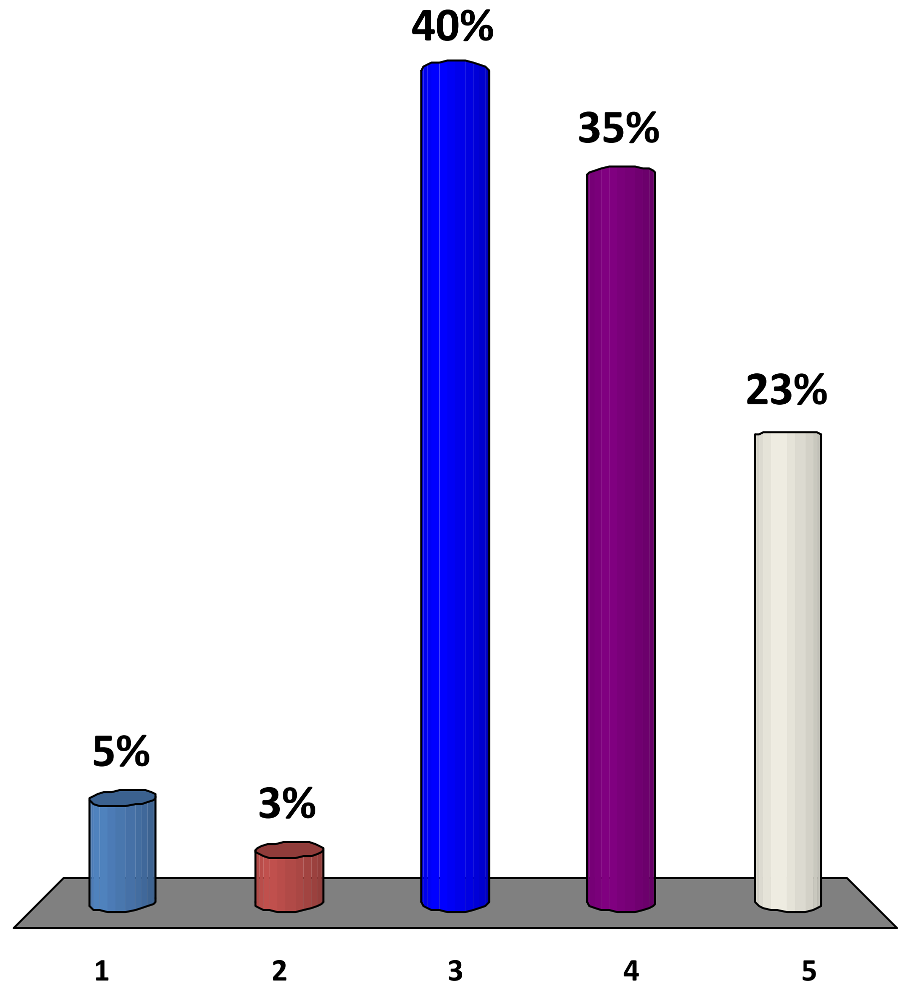
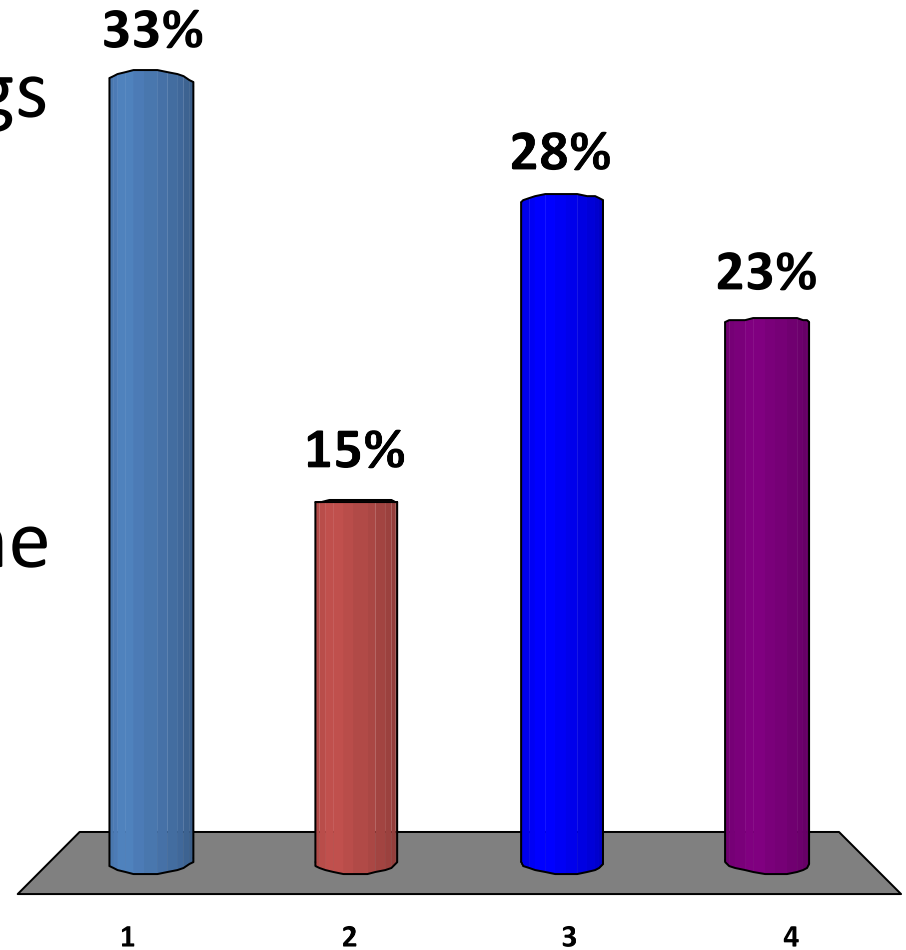
5. Other



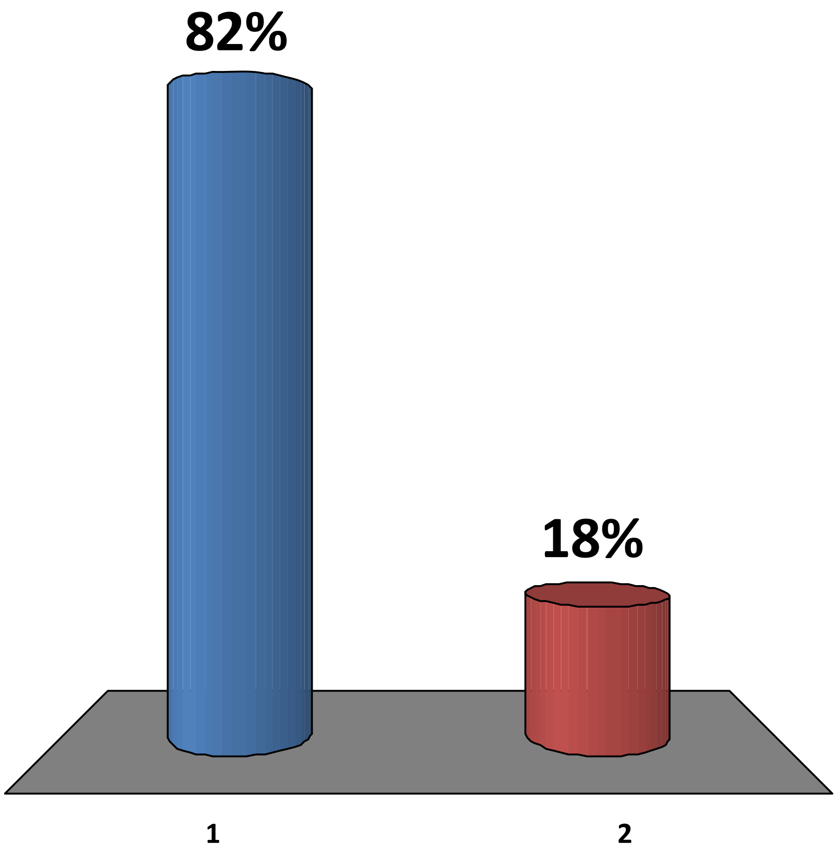
With a focus on the Millyard, what is **most important** to you?

1. Reuse existing buildings
2. Stronger connections to the downtown
3. Open space and recreation access to the Mousam River
4. Other



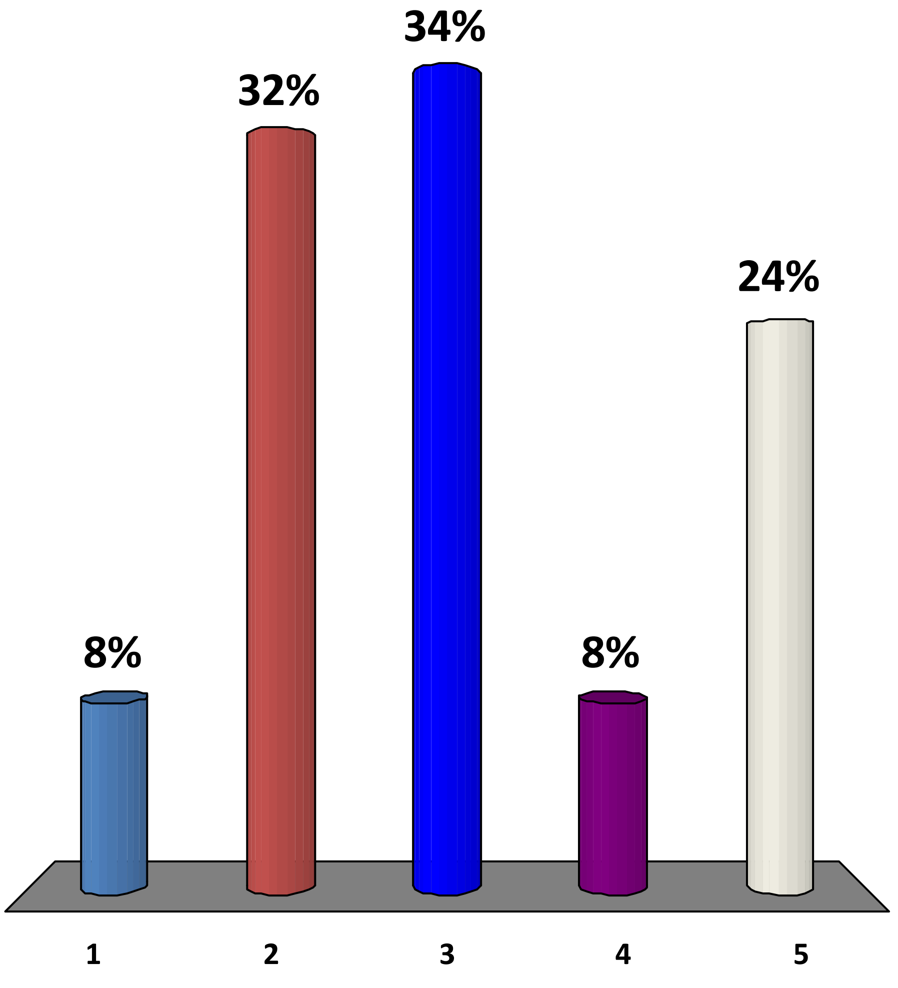
I think we should **preserve as much of the Millyard architecture** as possible?

1. Yes
2. No



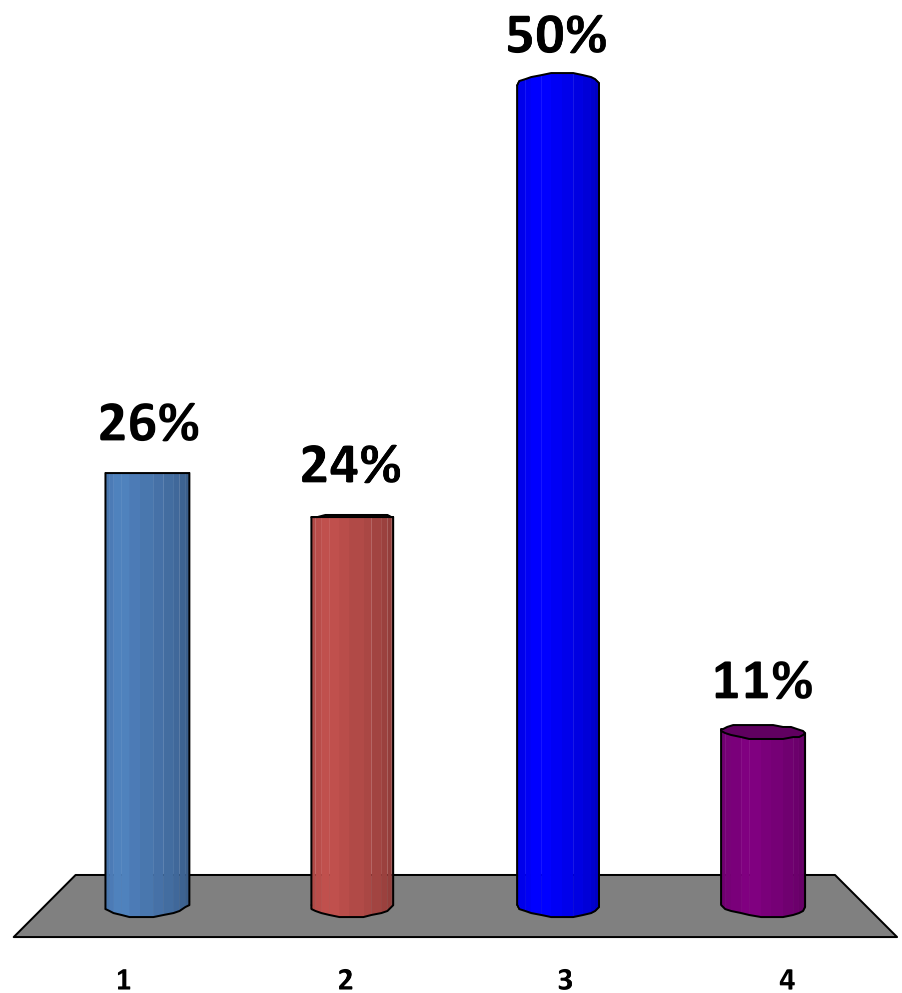
How should we measure **short-term** success?

1. It leads to future funding
2. It helps to change the image of the place
3. It increases jobs
4. It trains the next generation of work force
5. It cleans up our downtown



How should we measure **long-term** success?

1. It is implementable
2. People feel involved
3. The work is a catalyst for future development
4. All contaminated sites are cleaned up



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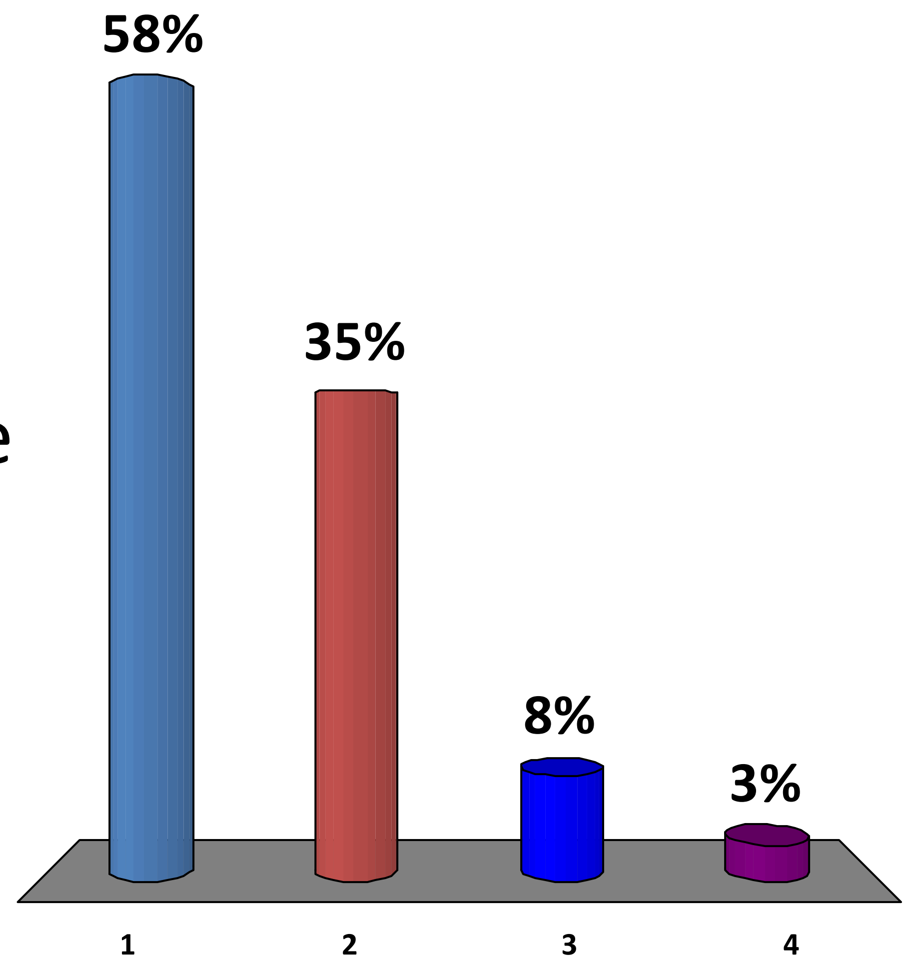
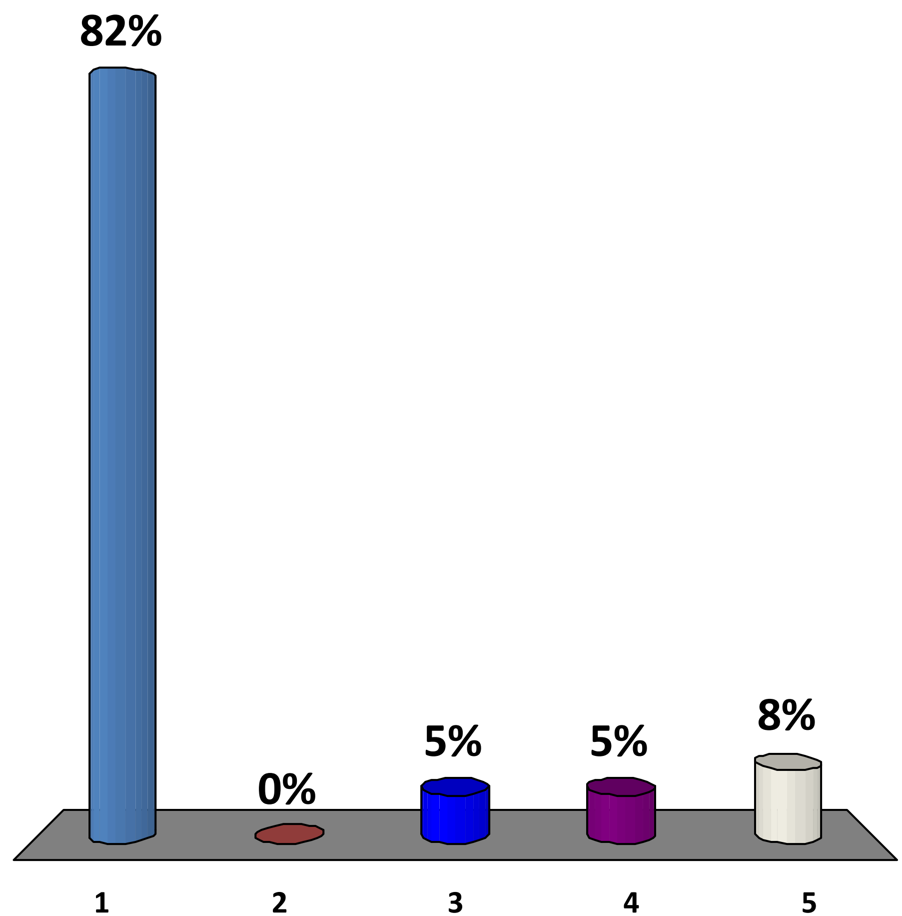


What kind of place does the Millyard need most?

1. Community Center
2. Coffee Shop
3. Bakery
4. Textile Museum
5. Kayak / Bike Rental



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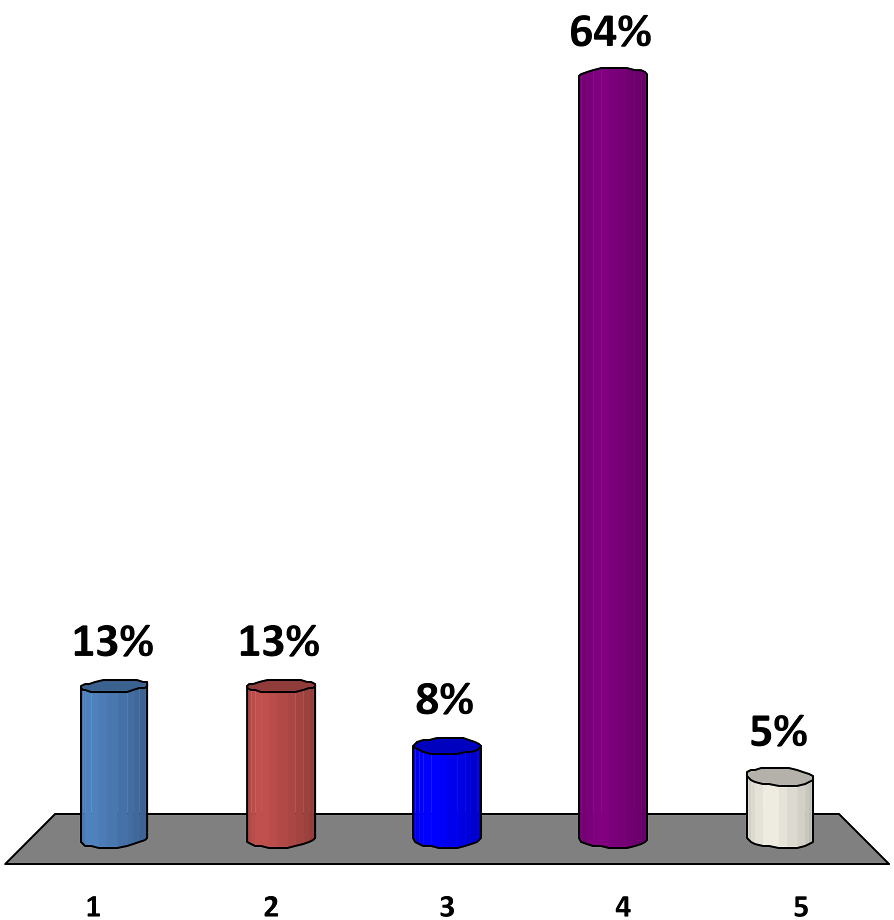
3. Artist studios
4. Indoor playground / rock climbing gym
5. Other



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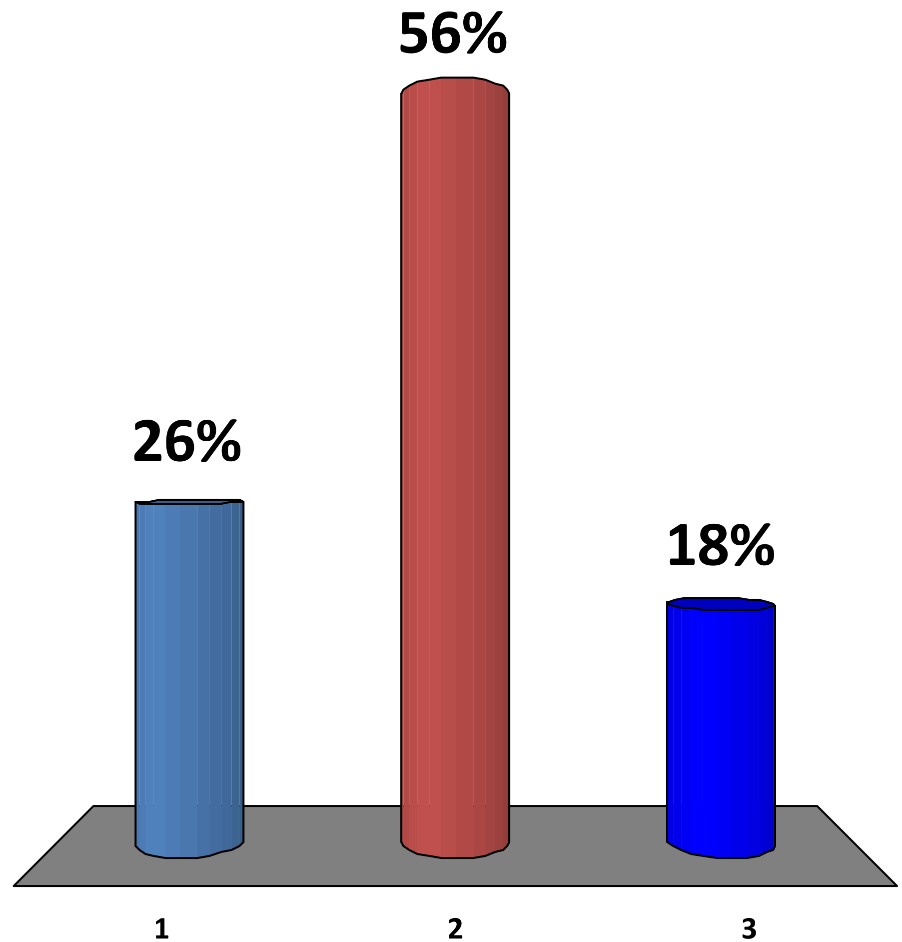
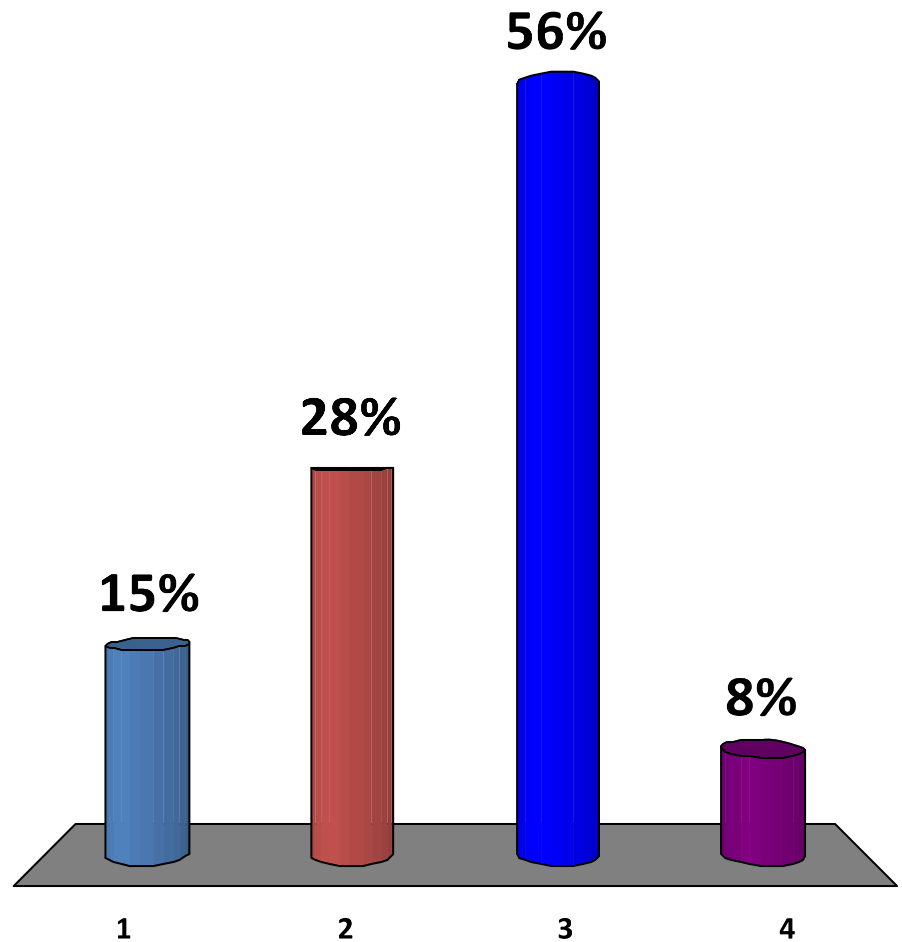
2. Demolish only the most dilapidated
3. Remove as many of the buildings as possible



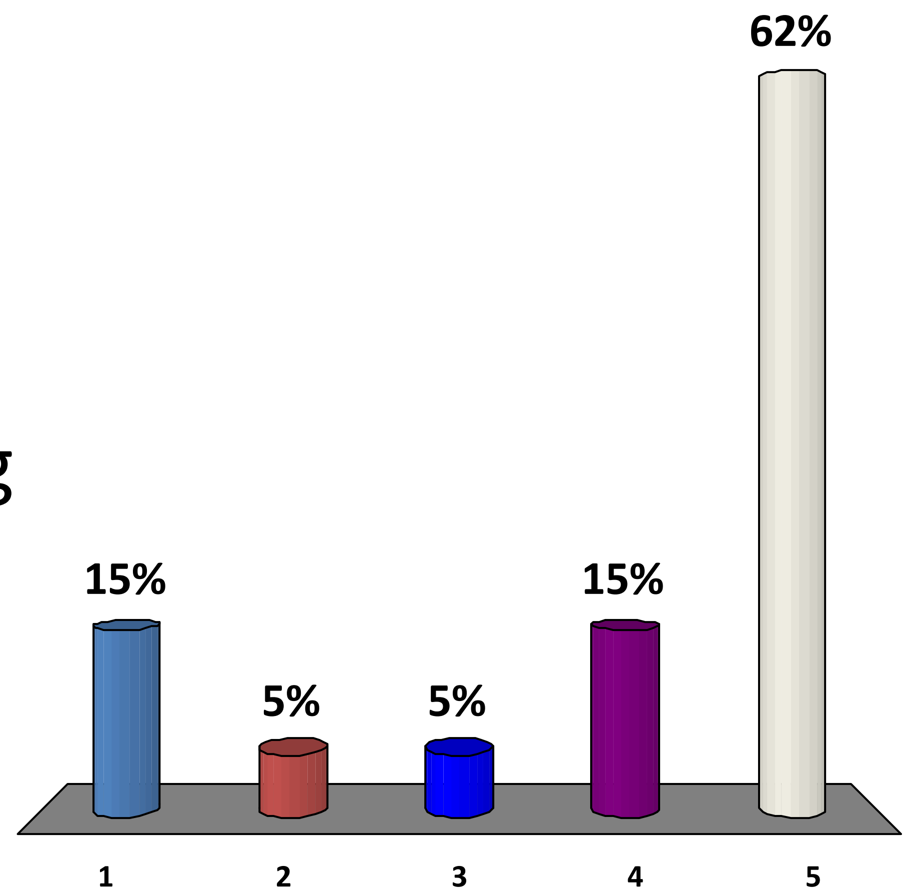
What is an appropriate character for the Millyard's **open space**?

1. Village-like setting
2. Extension of downtown
3. A unique, Millyard campus-like environment
4. Other



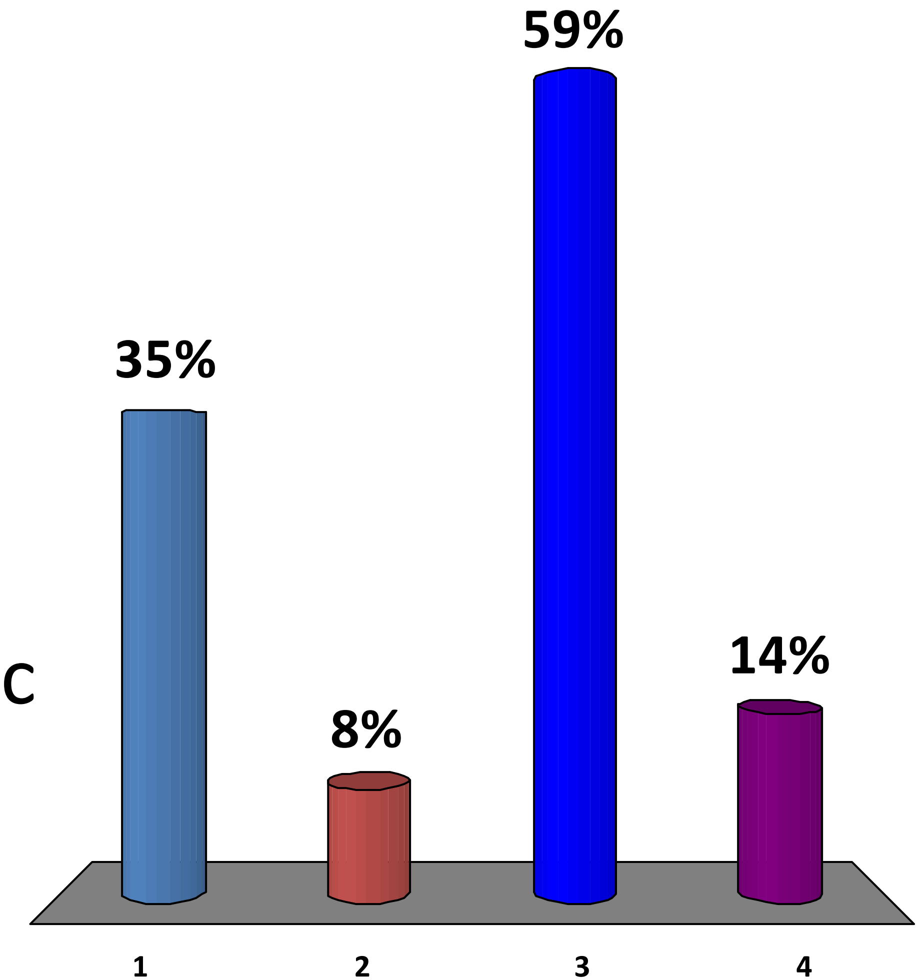
What are appropriate uses for **Number One Pond and Mousam River**?

1. Walking trails at edges
2. Non-motorized boat access (canoe/kayak)
3. Swimming and fishing
4. Power generation
5. All of the above



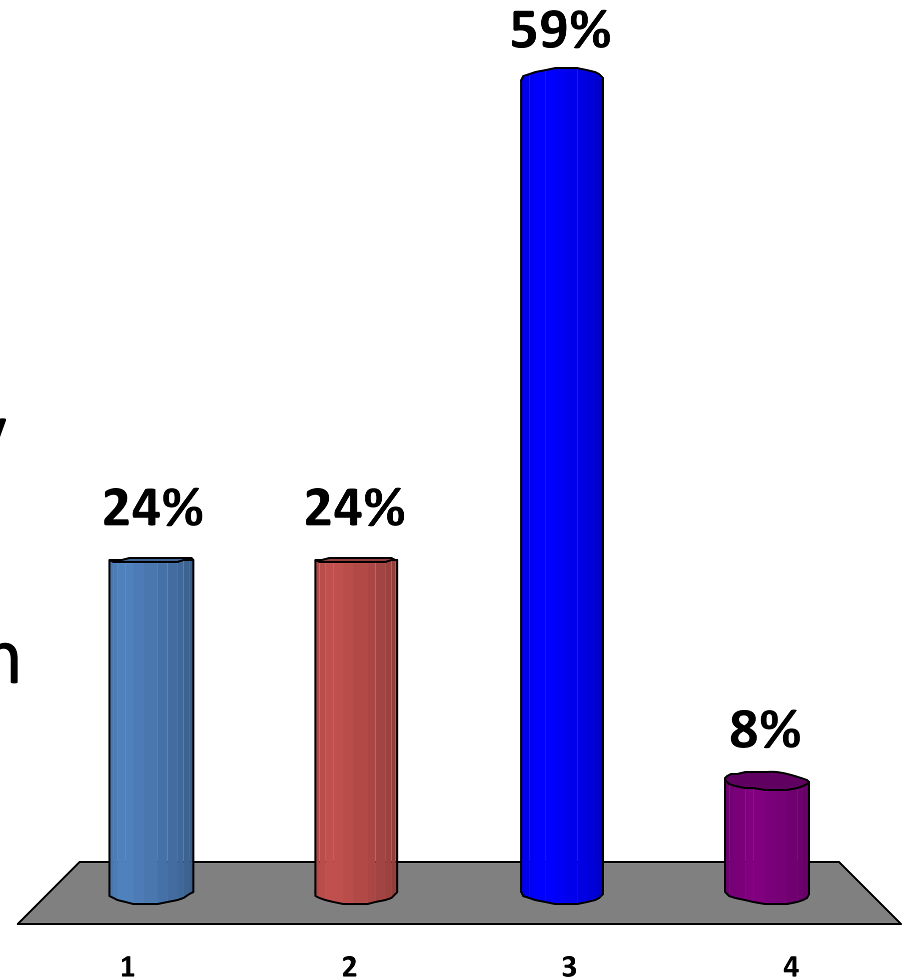
How should one accommodate the potential **parking demand**?

1. Structured parking
2. All surface parking
3. A mix of on-street, surface and structured parking
4. No parking, use public transportation



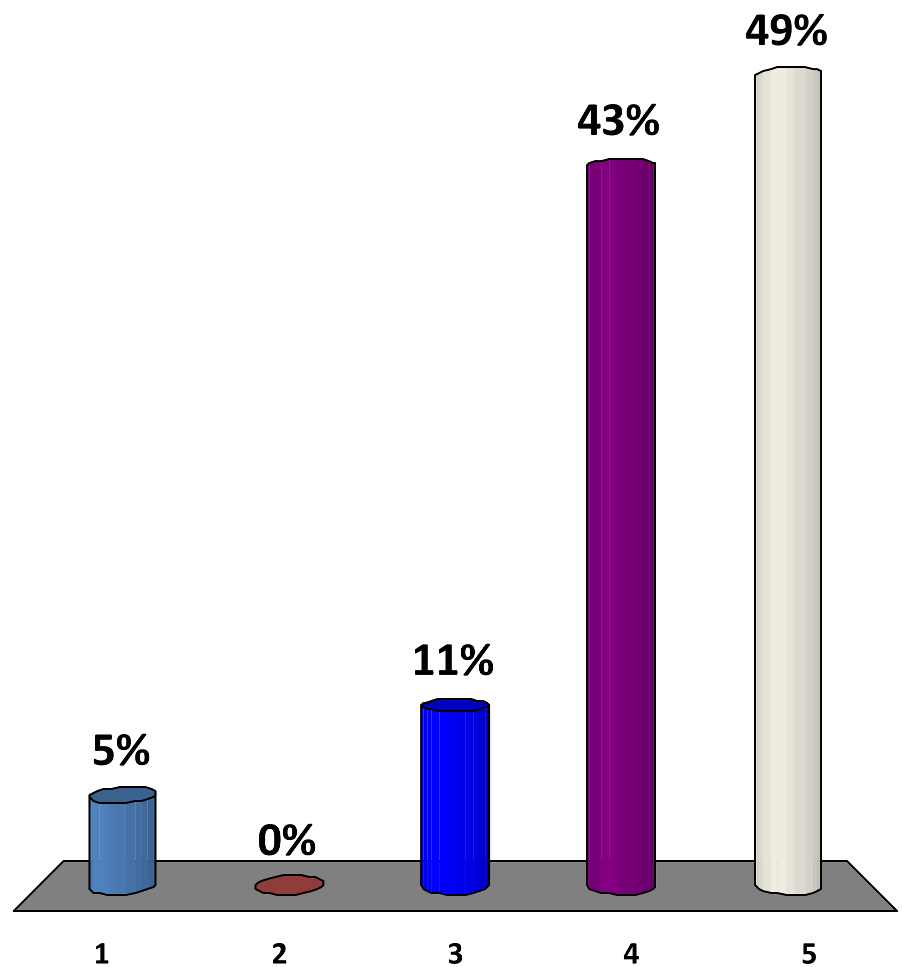
Which **brownfield sites** should be addressed first?

1. The most contaminated
2. Focus on the properties most likely to be rehabilitated
3. Remediate all of them as soon as possible
4. Other



Which is the most appropriate type of **renewable energy** for the Millyard?

1. Photovoltaic panels (on roofs)
2. Wind
3. Geothermal (ground)
4. Hydropower
5. All of the above




SANFORD,
MAINE
THANK YOU!
Brownfields Area-wide Planning
Pilot Program
Workshop
December 6, 2011

BROWNFIELDS

REGULATORY

VRAP to facilitate financing

INCENTIVES - REGULATORY

REGULATORY ASSISTANCE

HEALTH

Public Health + Environment

HEALTH BENEFIT.

IN THE URBAN CORE

AVAILABLE INFRASTRUCTURE

PRESERVE CHARACTER + IDENTITY OF SANFORD

INVESTMENT

AVAILABLE FUNDING

Prioritize $ Get Good "Bang for Buck"

IDENTIFY PROPERTIES AND AREAS IN NEED

UNCERTAINTY

FEAR

$$

ELIGIBILITY

POLITICAL WILL

DRIVERS

POLITICAL VISION! NEED! WILL!

OUTCOMES

Report Successes

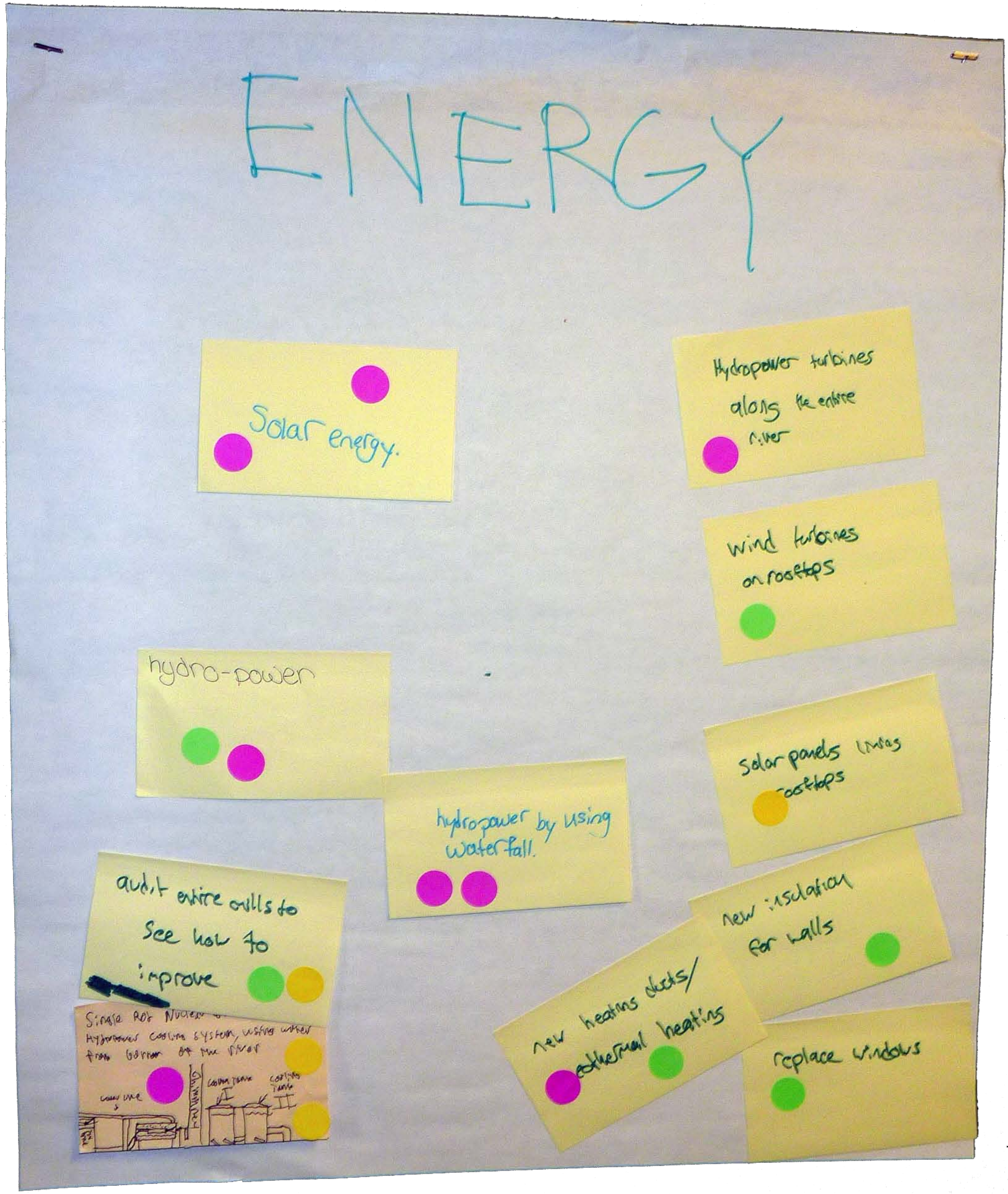
LEVERAGING JOBS + $

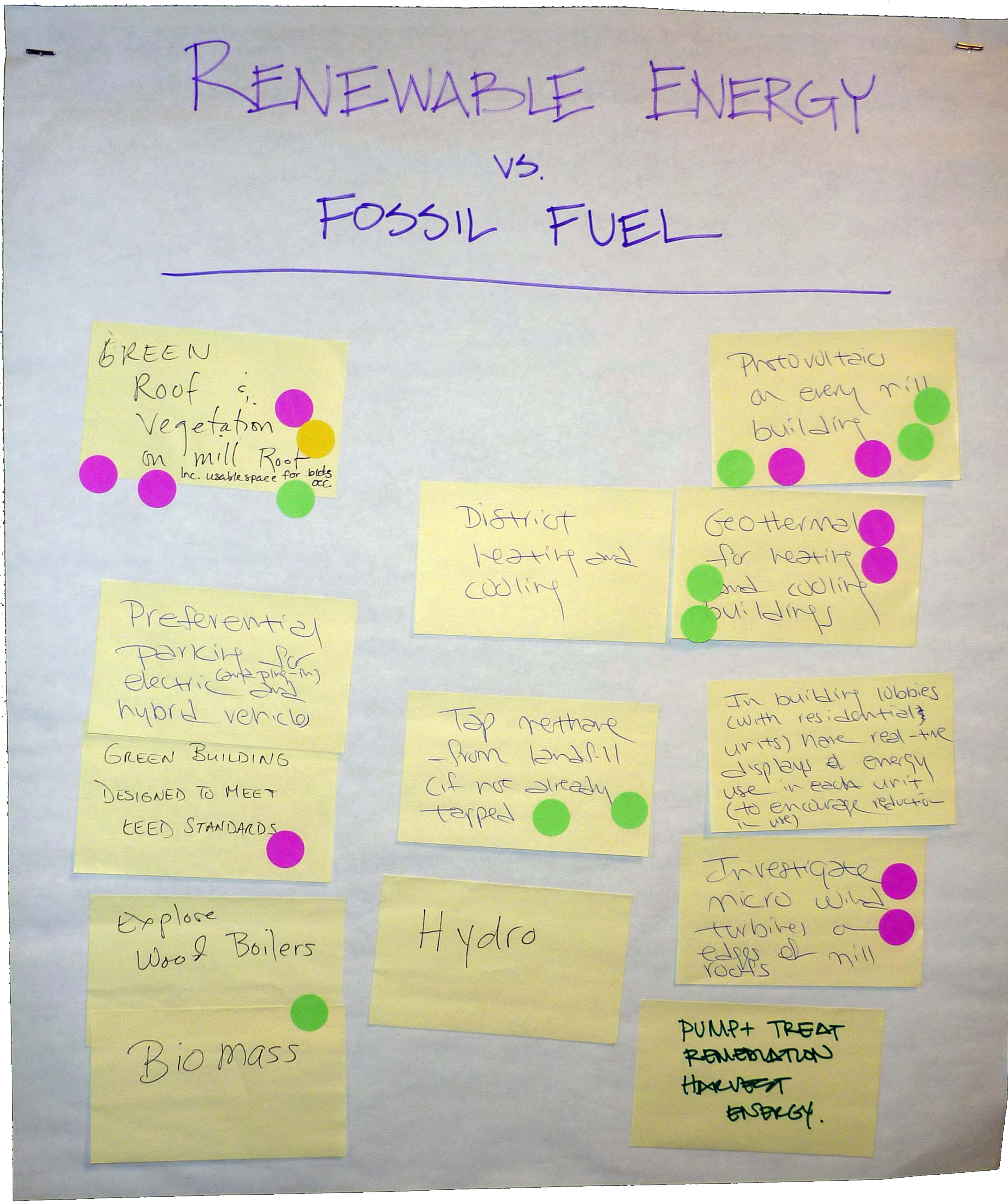
JOBS!

REWARD SUCCESS!

Viable Entities

Taxpayer $ spent wisely: actually returnable


ENERGY
Solar energy.
Hydropower turbines along the entire river
Wind turbines on rooftops
hydro-power
Solar panels
rooftops
hydropower by using waterfall.
audit entire walls to see how to improve
new insulation for walls
new heating ducts/ geothermal heating
replace windows
Hydropower cooling system, using water from bottom of the river
Cooling Tank I
Cooling Tank II


RENEWABLE ENERGY
vs.
FOSSIL FUEL
GREEN Roof & Vegetation on mill Roof
Inc. usable space for blds occ.
Photovoltaic on every mill building
District heating and cooling
Geothermal for heating and cooling buildings
Preferential parking for electric and hybrid vehicles
(and pine-ing)
GREEN BUILDING DESIGNED TO MEET LEED STANDARDS
Tap methane from landfill (if not already tapped)
In building lobbies (with residential units) have real-time displays of energy use in each unit (to encourage reduction in use)
Explore Wood Boilers
Hydro
Investigate micro wind turbines on edges of mill roofs
Biomass
PUMP + TREAT REMEDIATION HARVEST ENERGY.

INFRASTRUCTURE

Fix Gap in Trail Network for walking/Biking

Integrate Transit into any parking plan

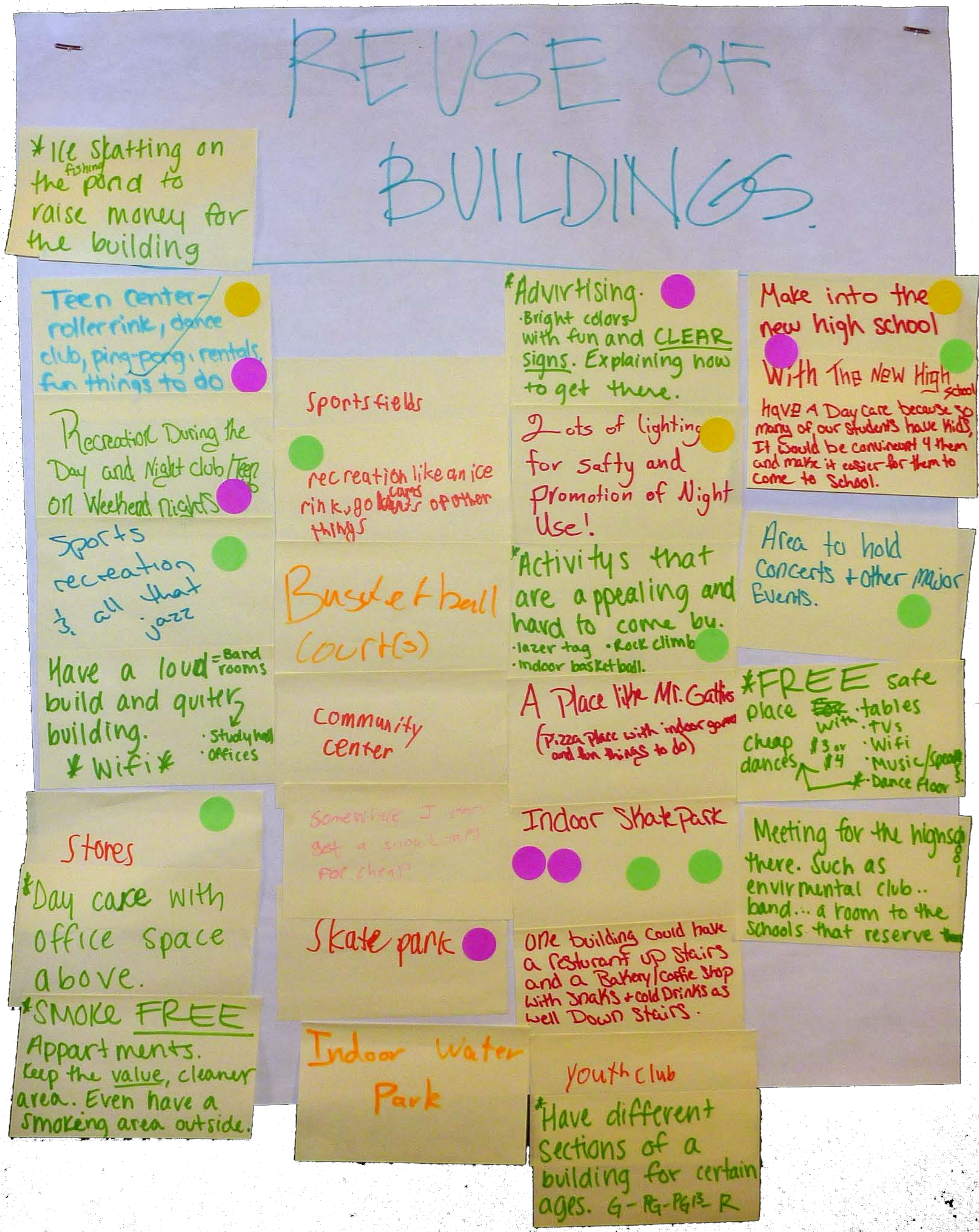
Transit Hub for Town

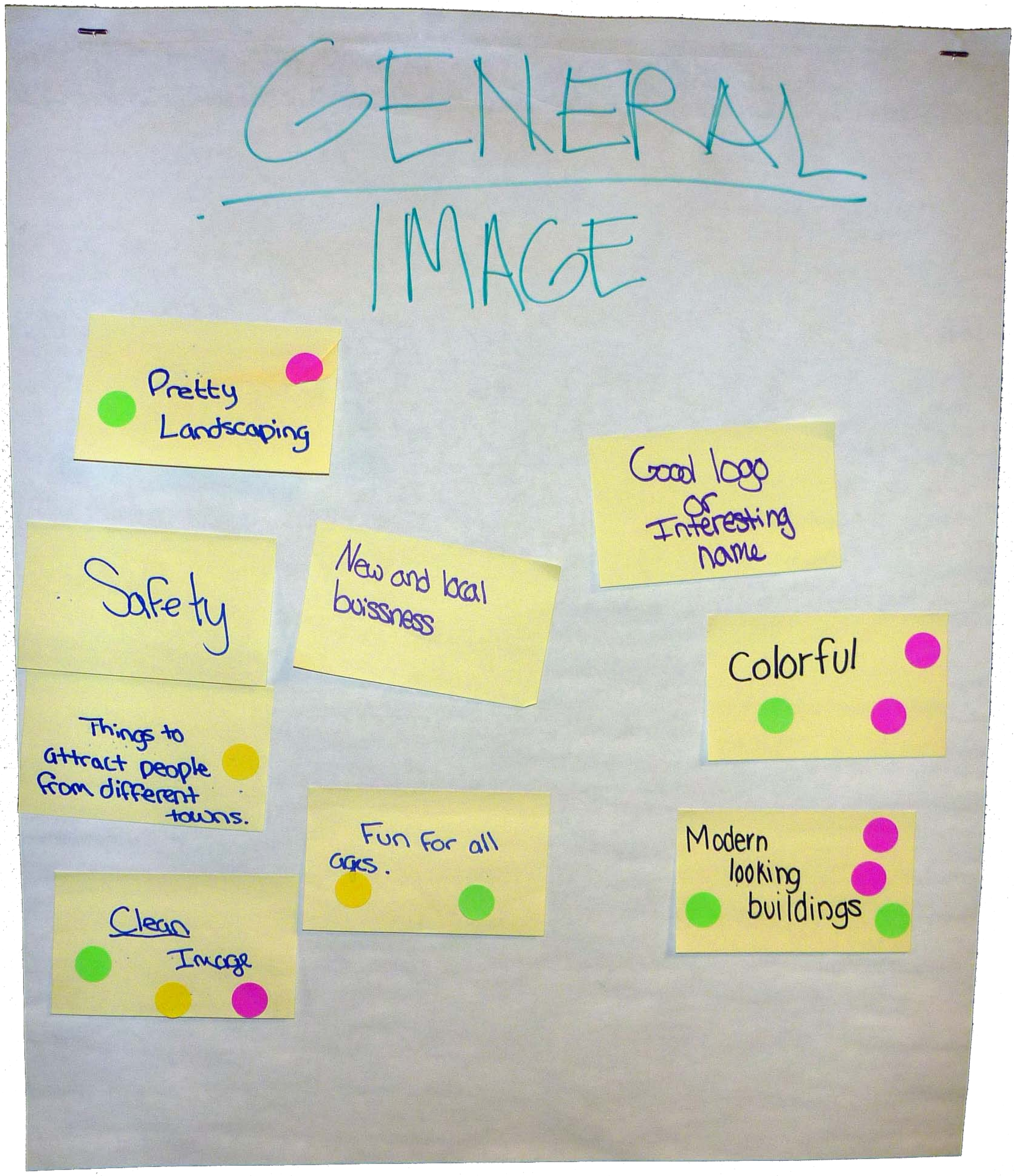
Reconstruction of "canal" area & pedestrian Bridge.

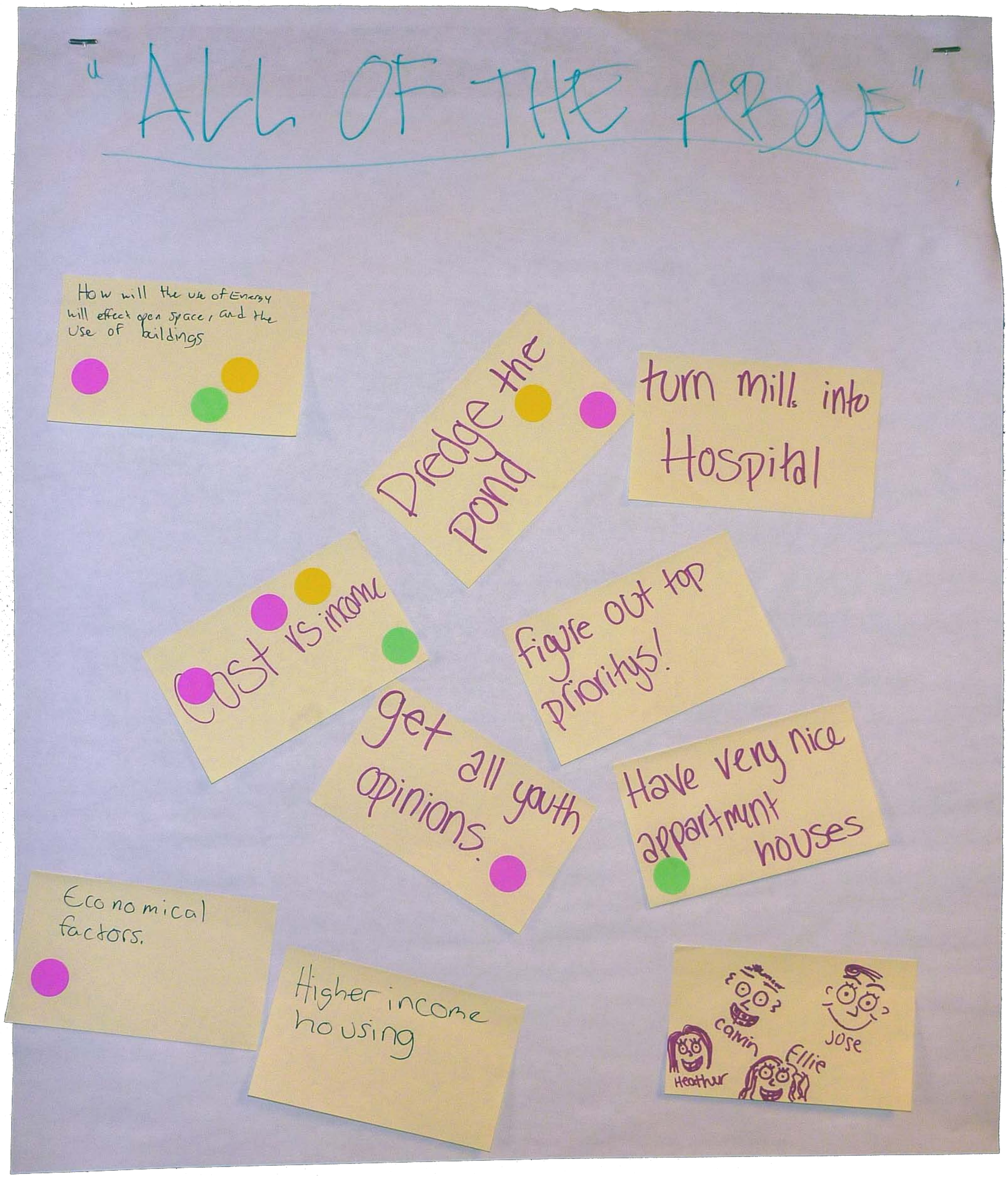
Update intersection
- Pioneer @ Washington
- River/High/Washington


NATURAL RESOURCES
PARKS
OPEN SPACE
PUBLIC/ COMMUNITY GARDENS
Connection to existing trail system ALONG RIVER / POND
Greener + More Walkable connections between Downtown/Mill Yard + Natural Resources
USE EXISTING RESIDENTIAL STREETS TO CONNECT DOWNTOWN W/ MILL DISTRICT
CREATE CONNECTION @ STAIRWAY (MORE ATTRACTIVE)
ACCENTUATE WATERFRONT
SMALL AMPHITHEATRE (LOCATION FOR PEOPLE TO GATHER FOR PERFORMANCES)
Improvement of access & recreational infrastructure of the pond & river greenspace corridor
CREATE -ACCESSIBLE "SAFE" PASSAGE
BODWELL ST. BECOMES PEDESTRIAN MALL.
DIRECT, ATTRACTIVE CONNECTION NEAR "CITY LIMITS" BAR
DESIGN FOR WINTER USE... (ICE SKATING...)
CREATE A RIVER WALK
CREATION OF PLAZAS + PEDESTRIAN NODES
HISTORICAL TROLLY TRAIL (STOPS @ MILL AREA)
CREATE VIEWS OF MILL FROM MAIN STREET
GATEWAY TO MILL YARD (AND NATURAL RESOURCES)
LIGHT UP DAM - CREATE POCKET PARK


OPEN SPACE
Lacrosse Field!
Expand the ponds
Vollyball
Playground
Public art. (like the art show) display.
Make a Park!
Put a public Park.
Clean the area.
Flowers
Clean the Pond!
Multi-sport area (soccer, lacrosse, football!)
Trails!
Green [house] place/ garden.
Landscape the area.
Garden!
Dog Park!
Picnic
of trees!
Plants
Feild Hockey Feild


REUSE OF BUILDINGS.
*Ice skatting on the fishing pond to raise money for the building
Teen center - roller rink, dance club, ping-pong, rentals, fun things to do
Recreation During the Day and Night club/Teen on Weekend nights
Sports recreation & all that jazz
Have a loud build and quiter building. = Band rooms · Study hall · Offices *Wifi*
Stores
*Day care with office space above.
*SMOKE FREE Appartments. Keep the value, cleaner area. Even have a smokeing area outside.
Sports fields
recreation like an ice rink, go karts or other things
Basketball court(s)
community center
Skate park
Indoor Water Park
*Advirtising. · Bright colors with fun and CLEAR signs. Explaining how to get there.
Lots of lighting for safty and Promotion of Night Use!
*Activitys that are appealing and hard to come by. · lazer tag · Rock climb · indoor basketball.
A Place like Mr. Gatti's (pizza place with indoor games and fun things to do)
Indoor Skate Park
one building could have a resturant up stairs and a Bakery/coffie shop with snaks + cold Drinks as well Down stairs.
youth club
*Have different sections of a building for certain ages. G - PG - PG13 - R
Make into the new high school
With The New High school have A Day care because so many of our students have kids, It would be convinent 4 them and make it easier for them to come to school.
Area to hold concerts + other major Events.
*FREE safe place with · tables · TVs · Wifi · Music/speakers · Dance floor. Cheap dances $3 or $4
Meeting for the highschool there. Such as envirmental club.. band... a room to the schools that reserve them


GENERAL IMAGE
Pretty Landscaping
Good logo or Interesting name
Safety
New and local buissness
Colorful
Things to attract people from different towns.
Fun for all ages.
Modern looking buildings
Clean Image


"ALL OF THE ABOVE"
How will the use of Energy will effect open space, and the Use of buildings
Dredge the pond
turn mills into Hospital
Cost vs income
figure out top prioritys!
get all youth opinions.
Have very nice appartmint houses
Economical factors.
Higher income housing
Calvin
Jose
Heather
Ellie

Student Input Gathered at the December 6th, 2011 Presentation to Sanford High School and Sanford Regional Technical Center Students

SECTION 4

ECONOMIC DEVELOPMENT

4. ECONOMIC DEVELOPMENT

NEIGHBORHOOD STABILIZATION:

The reuse of the Millyard buildings will have significant and ongoing economic impact beyond the historic buildings themselves. The buildings and the legacy they represent can be the foundation for new economic development. A commitment to reinvesting in the Millyard is also a commitment to the downtown, particularly the older residential neighborhoods nearby, the Midtown Mall and Main Street. By focusing attention and policies to the Millyard, Sanford is directing resources to the area that needs them most thereby creating a catalyst that will create a ripple effect of pride of place that will lead to improvement and ultimately private investment.

INCREMENTAL GROWTH:

The rehabilitation and reuse of the Millyard will take a generation or more to become a destination in and of itself. One must look beyond traditional market analyses and seek out **a mix of place-specific, non-traditional uses** that can create vitality and reposition a property or district as an interesting destination. Over time, these initial uses can **build value and generate a more positive image** for the area that leads to new interest in the remaining unoccupied space.

Some of these unique uses may include tenants like **Eastern Mountain Sports**, a company whose goal is to help people experience all aspects of outdoor recreation. They often hold outdoor demonstration expos where individuals can try outdoor gear like kayaks, bicycles, hiking boots, running shoes, mountain climbing, and camping gear. The Millyard offers a compelling setting for a regional retail location as well as a place for these outdoor demonstration events.

Another potential business fit comes from the indoor agriculture industry. These businesses, whether they grow tomatoes like Backyard Farms in Madison, Maine or mushrooms like Farming Fungii LLC, also of Maine, have a need for large open floor plates, access to sufficient clean water, and inexpensive power. The Millyard buildings also offer loading docks and direct access to air distribution through the Sanford Airport.

Industrial education and vocational training also offer a strong fit for use of the existing mill building infrastructure. The Sanford Regional Technical Center offers programs in automotive, building trades, computer-aided design and drafting (CADD), culinary arts, environmental science, health occupations, precision manufacturing and welding among others. These programs provide hands-on job training for students and prepare them for careers in professional trades. The Millyard offers a potential venue for some of these programs to expand based on the continued demand for skilled workforce labor.

The Nellie Mae Education Foundation (NMEF), the largest charitable organization in New England focused exclusively on education, has awarded a $3.7 Million grant distributed over three years to support student-centered approaches to learning among in Sanford, Maine. The grant will support the ongoing efforts of the Sanford School System to implement long-term plans to reshape their systems to help all students succeed at a higher level in an increasingly changing world. Part of these grant monies will be allocated to re-branding Sanford's educational system and communicating the profound work being done throughout the district. It is possible that expanding technical support facilities to the Millyard can help boost an already rising star in the Sanford School System.

TRANSIT:

The construction of the Federal Transit Authority (FTA)-funded Sanford Transit Center (STC) is an added benefit for the Millyard's redevelopment. It will enable more people to access the area and create a multi-modal destination for pedestrians, bikes, and buses. **The proximity of the STC in downtown and adjacency to the Mill complex will allow for greater connectivity**.

CITY VISIONS ASSOCIATES

ECONOMIC DEVELOPMENT

Sanford Mill District:
Assets
- Mill Properties Structurally Sound; relatively well maintained
- Motivated owner/potential partner in WASCO
- Strong potential link to downtown
- Road investments already made
- Parking likely can be incorporated within
- Rich historical fabric
- District relatively intact
- Initial activity underway (Northland)

Sanford Mill District:
Challenges
- Limited local demand
- Far too much space available
- Lack of clarity in Fratti goals for his property
- Int'l Woolen Mills negative value (cost of clean-out likely exceeds disposition receipts)
- Mills properties similar to many similar vacant mill properties throughout Maine; lacks distinguishing characteristics
- No redevelopment strategy in place (current)
- Sanford "under the radar" as business location (current)

Town of Sanford:
Assets
- Mousam River scenic value: waterfalls, ponds, integration into Town's industrial past
- Connection to regional system of water-based recreation and trails. Headquarters location?
- Access to Boston markets
- Potential energy production (solar + small scale hydro power)

Town of Sanford:
Challenges
- Major water features mostly hidden or out of view
- Lack of strong identity
- Few businesses utilizing access to Boston markets
- Competitive disadvantage with coastal communities

Market Demand
- Limited potential based solely on internal characteristics and current conditions

- Initial likely tenancy will be more difficult without <u>strong plan for remainder of Mill Yard</u>
- "Value" of Mill District location will be determined to a great extent by the strength of the draw/interest in Town of Sanford as <u>a community with a particular niche</u>.
- Important to <u>start small, with viable initial project/tenant that helps build value and reinforces the character of the area</u>.
- Initial project and community "repositioning" need to move forward simultaneously

Sanford Mill District:
<u>Preliminary Conclusion</u>

- "The ability to craft and implement a successful redevelopment program for the Sanford Mill District properties depends as much on the desirability of the Town of Sanford as a business location as it does on the specifications and economics of the properties themselves. The most strategic approach is to <u>build upon Sanford's existing assets in the development of a "brand" that is focused on a specific market niche</u> most likely to benefit from the assets of the Town, and that is not currently identified with any other community in Maine."

Sanford Market Niche:
<u>A Center for…</u>

- <u>Sustainability</u>
- <u>Healthy Lifestyle</u>
- <u>Outdoor Recreation</u>

<u>The Town of Sanford:</u>
<u>A Center for Sustainability/Healthy Lifestyle/Recreation</u>

- Strong connections to regional trail and river recreation system
- Hydro power (small scale) potential to serve Mill District tenants
- Usable water flow (unmetered) potential for certain businesses/industries
- Environmental model (national model) of restoration of Mill Pond #2
- Reuse of major existing mill buildings
- Historic- and continued (small scale) production of natural fabrics

<u>Example Tenants</u>

- <u>SUSTAINABLE ANCHORS</u>
- The Textile Museum
- Center for Manufacturing Excellence
- Maine Innovation Center
- Vo-Tech Education
- Solar Innovations
- Wasco Welding Warehouse
- <u>HEALTH + WELLNESS</u>
- Sanford Senior Center
- Daisy's DayCare
- Endorfun Sports

- York County Yoga
- Health + Wellness Clinic
- Organic Grocery
- Hydroponic Farming
- Bodwell Bodyshop

Potential Niche Business/Tenants Profile

- Natural/organic businesses with large scale space/water requirements: e.g. Coffee roasters, hydroponics, natural fabric production
- Aquatic recreation –base businesses (e.g. canoe/kayak production/sales/rental
- Energy related users (e.g. solar panels, etc)
- Ancillary synergistic uses (microbreweries, fabric shops, natural foods, etc)
- Small, working Maine textile museum/center (may not be sustainable on its own, but would be more viable as part of a community/district theme)
- Distinct and different from market of coastal communities

NOTE: This niche could ultimately attract retail tenants, but early focus should not be on wholesale/production. Availability of inexpensive space with good access to Boston market is a stronger case statement than retailing that depends upon traffic volumes

Sanford Mill District Strategy

- *Property Acquisition*: Current assumption that best option is to attempt to publicly acquire Fratti property. Given the limited financial options available to the owner without a "partnership" with the Town, an outright acquisition would be overly burdensome for the Town financially, and reduce the attractiveness of the owner considering other options in which his value may increase over time.

- *Parking*: is necessary in any reuse scenario, with structured parking much more expensive than surface parking. Even with surface parking, some selective demolition would be required. While this may have residual benefits in reducing the overall square footage, it is suggested that the first parking option to be considered would be to accommodate parking needs within certain corridors of the existing mill properties. This will also reduce square footage and reduce costs as well

- *Public Sector Leverage:* The redevelopment of the Mill District will be a long term effort, and early catalytic actions that can jump-start activity and interest should be prioritized. Actions in which the Town and/or other public sector actors can influence and leverage early activity should be pursued aggressively. Examples of such potential leveraging actions include the location of the Vo-Tech School in the Mill District as well as other programs and certain components of the High School that can not only provide a richness to these programs, but indicate to potential private businesses and tenants that the community supports the Mill District Plan in action, not mere words.

Sanford Mill District Strategy:

Next Steps (preliminary)

1. Consider and evaluate **Sustainability/Healthy Lifestyle "Niche**" more fully (or determine alternative niche). Without a more clearly defined targeted strategy, the Sanford Mill properties will have difficulty competing with many other similar properties available throughout the State
2. Actively assess/investigate the reintroduction of **alternate power potentials** and the re-creation of Number 2 Pond. Both can become integral elements of the strategy and provide extremely valuable publicity, recognition, and reinforcement of the new focus of the community.
3. Begin direct discussions with the owner of the **International Woolen Mill** property**,** advising him of the economic potential of certain redevelopment strategies and partnerships utilizing a variety of tax credit programs that may likely provide him with more financial benefits that selling the property.
4. Likewise, begin similar discussions with the owner of the **WASCO property**
5. Undertake a detailed redevelopment analysis of the Mill District properties under such **a market niche strategy**. Such an analysis will determine phasing, initial targeted property redevelopment and tenancy and future phases, development partnership options and tax credit analysis, public infrastructure needs.
6. Develop a partnership with the entities involved with **the Maine Clean Tech Corridor** (University of Maine's Department of Industrial Cooperation, New England Clean Energy Council, E2Tech).
7. Begin **outreach to targeted business niches**
8. Pursue **partnership opportunities** with the proposed new Voc-Tech School and the High School

POCKET GUIDE TEXT: Economics

The ability to craft and implement a successful redevelopment program for the Sanford Mill District depends as much on the desirability of the Town of Sanford as **a business location** as it does on the economics of the properties themselves. The most strategic approach is to build upon **Sanford's existing assets** in the development of a new "brand". The brand must be focused on a specific market niche that is most likely to benefit from the assets of the Town as a whole, and one that is not currently identified with any other community in Maine.

Sanford's market niche is to become a Center for Sustainability, Healthy Lifestyle and Outdoor Recreation. The Town already has a strong trail network and culture of water recreation. The Mousam River and a new Riverwalk build on this system. The incremental reuse of the Millyard complex, and the creation of a new Riveryard centered around "Number 2 Pond", help to connect the redevelopment of the Mills with the remediation of the land adjacent to them.

With close proximity to downtown and a rich building fabric, the rehabilitation of the mill buildings themselves are already in progress with new residential housing in the Sanford Mill. Additional tenants centered around the culture of industry can foster a linkage to the area's rich tradition of fabrication and production of natural fabrics. Renewable energy technologies (solar, hydropower and geothermal) offer a potential to attract certain industries that would not otherwise come to the Millyard. These technologies combine to create a national environmental model for power generation and sustainability.

The redevelopment of the Mill District will be a long term effort. Nevertheless, early catalytic actions can jump-start activity and interest. Actions in which the Town and/or other public sector actors can influence early activity must be aggressively pursued. Examples of such potential leveraging actions include attracting **institutional or educational anchors** that can complement their existing programs and signal to potential private businesses and tenants that the community supports the Mill District Plan. It is critical to start small, with a viable initial project and tenant that helps build value and reinforces the character of the area.

GLC

MEMORANDUM

To: Cheri Ruane, Team Leader, Landscape Architecture, Weston & Sampson

CC: Drew Leff, Principal, GLC Development Resources LLC
David Gamble, Principal, Gamble Associates

From: Arthur Jemison, Senior Project Manager, GLC Development Resources LLC

Date: November 30, 2011

RE: Economic Development Recommendations & Market Analysis, Sanford Mill Yard, Sanford, ME

Executive Summary

The Town of Sanford has engaged Weston & Sampson, Gamble Associates and GLC Development Resources to identify a land use plan and development strategy to revitalize the Sanford Mill Yard.

The role of the Economic Development Recommendations & Market Analysis is to identify which land uses should be targeted for properties which are not currently being redeveloped in the Mill Yard, such as the WASCO Building, and the International Woolens Building. We are also charged, with the rest of team, to think about the area along the Mousam River as it travels through the Mill Yard. As the development voice on the team, we have used data, interviews and comparisons to identify what uses are feasible and what strategy should we use to effectuate redevelopment.

The Mill Yard area presents a unique opportunity for a public-private redevelopment project. To understand the public actions that should be taken to enable redevelopment of the Mill Yard, there needs to be a clear view of the market perspective of the properties.

Our market assessment is that Sanford, like many of New England former industrial communities has symptoms of a “weak” market: a market which includes lower residential and commercial rents, an oversupply of commercial space; and is separated from the drawing power of the strong market in Portland, ME and its surrounding area, by I-95.

This is only the beginning of the story, however. Sanford, ME is well positioned to be one of a series of successful, former industrial communities in New England by embracing ideas from places like Holyoke, MA, Pittsfield, MA and Lewiston, ME. The broad strategies that have been successful are:

GLC DEVELOPMENT RESOURCES LLC
20 PARK PLAZA, BOSTON, MA 02116 I TEL: 617.262.2131 I FAX: 617.262.5509 I www.glcdevelopment.com

- Mill properties are usually quite large and re-occupancy of these properties (residential and commercial re-use) requires parking resources, preferably on grade parking resources. Our clients and people interviewed in comparable cities like Lewiston, ME and Lawrence, MA indicate that identifying a specific parking strategy enables redevelopment of large mill buildings.

- Effective partnering with development interests is also critical to redevelopment in comparable cities: in Lewiston, the City partnered with Tom Platz of Auburn to redevelop several former mill buildings through a joint venture to develop new parking facilities and improve roads.

- Clustering certain land uses for purposes of attracting tenants and residents. Specifically a) education/institutional use; b) residential use; and c) private industry in a roughly 30% each ratio. In underdeveloped sections of Vancouver, BC; Portland, OR and even Holyoke, MA, cities and states are trying to attract investment to these areas and generate the clustering that has generated new jobs. These areas have been dubbed "Innovation Districts". Some of the early ones in Europe have begun to bear fruit.

- Successful redevelopment of the Mill Yard buildings will require leverage of public sector resources such as Historic Tax Credits, New Market Tax Credits and as necessary LIHTC, TIF and other sources.

Crafting an economic development strategy for the Mill Yard also requires a considering how private development interests would approach the properties and using this as a guide for prioritizing the related public investments.

Based on our experience, we believe private development interests would seek control WASCO and International Woolens properties. [We recognize the challenges of site control for the Town.] Depending on the scale of carrying costs, development interests would likely demolish the eastern section of the WASCO Property for a surface parking lot that could provide up to [300] spaces, unless a less-expensive parking field was available or developable near the building.

Based on our calculations, included as **Attachment 1**, a feasible mixed-use re-development of the remaining buildings in the Mill Yard would be best led by a commercial use supported by historic tax credits (HTC) and new markets tax credits (NMTC).

Next, development interests would seek a commercial "identity" to help attract tenants. The idea of an innovation district in Sanford, which has the potential residential use in the Northland and Stone & Stone Buildings; and opportunities for the private redevelopment in International Woolens; as well as institutional presence of Goodall Hospital in Sanford suggests there may be linkages that could help market the Mill Yard. Add to this the positive changes in educational attainment in Sanford and York County, and there may be an identity for the Town to market.

Finally, development interests would likely seek private and public sources to repair and improve the existing International Woolens building, which seems to be in the best condition. They would likely divide the 300,000 SF building into discrete segments of 75,000-150,000 square feet (SF) with a commercial office segment of up to 70,000 125,000 SF in commercial and 5,000-10,000 SF of retail, for example. This would allow development to come to the International Woolens property with the least amount of additional parking facilities until there is proven demand.

Economic Development Strategy Recommendations

What would induce a developer to take the risk of buying and controlling this property? The answer is a tenant ready to occupy the space; and a series of enabling actions by the public sector. While we cannot control the tenants, we can identify the enabling actions the public sector can undertake.

Our strategic recommendation is that the Town create a "place" within the Mill Yard around which redevelopment will occur. On the basis of our review of conditions, we recommend the following actions to induce that developer and thus that tenant to the Mill Yard.

- *Advance current residential projects* One element of creating a place is populating it with the residents that patronize the retail and potentially work in the new facilities. Residents are critical to the redevelopment of the effort and all reasonable steps should be taken to ensure that the residential goes forward and is occupied.

- *Create parking* Whether it is through the demolition of existing buildings (which we prefer) or a well-designed parking field on the new roadway, parking will be needed to re-occupy all the Mill Yard buildings. Just re-occupancy of the 300,000 SF International Woolens building will require 750 parking spaces at a 2.5 spaces per 1,000 SF ratio. Parking will be critical element to the re-occupancy of the Mill-yard.

- *Source and Execute Public Improvements*

    - A well-designed ADA compliant pedestrian connection from the Mill Yard to Bodwell Street that brings residents and visitors from downtown to the Mill Yard area.
    - Place-making improvements (anything from special pavers and an improved roadway to a boardwalk along the canal) in the area between International Woolens and the Northland Building along the Canal through which the Mousam River travels from Pond #1 have the potential to set the context for future re-occupancy of the properties.
    - Canal improvements, as have been suggested by the work of Weston & Sampson, which will both remediate the environmental conditions in the wall and soil in the canal but which also bring the community to the Canal point that is near the "place" made at the Canal, as described above.
    - An attraction like a programmable open space in the area along the Mousam River on the Mill Yard side. This could include elements like a boardwalk, kayak

and canoe launches, and if possible the potential to have a "pond" ice rink. The head house for this programming could be at the place described above or at out in the open space where the ice and canoe launches are located.

- *Create energy infrastructure*

    - Using the energy generation resources, such as from the City's right of way through the Mill Yard could be a way to immediately access geo-thermal resources that would support the redevelopment of the Mill Yard buildings by reducing a potential user's occupancy costs.
    - In lieu of development agreements with the owners of WASCO and International Woolens, the Town could seek agreements that allow installation of solar equipment, the value of which could be an element of price or equity contribution for eventual acquisition of the properties by some party.

Together with the 300+ units proposed for the Mill Yard, this initiative and these public improvements could be marketed as and result in a mixed-use "Innovation District", a mixed-use "place" that can attract development partners and most important institutional users for the space. While industrial park space and space like it is relatively plentiful in the area, a well design mixed use area is much less common. When implemented, this could help to develop a live- and work-recreation environment connected to downtown that can support Sanford's growth.

Market Analysis Summary Findings

- Sanford is demographically stable but is not growing at this time. There is demographic strength in broader York County which is growing, that can be attracted to Sanford with implications for the residential, and eventually the commercial marketplace.

- There is insufficient market demand for market development of new residential and commercial space. With housing subsidies however, and a ceiling for "affordable rents" that far exceeds Sanford rents allowing units to be eligible to a number of units. Brady Sullivan's proposed development is promising and includes 4% Low Income Housing Tax Credits (LIHTC) in its project economics.

- In the commercial marketplace, there is growth in retail with strip-style developments, which are continuing to be privately developed. In the office/industrial category, there is less activity and a significant amount of vacant mill space available, as well as industrial park space and some second floor space downtown available.

- Based on demand and the condition of the mills, there is too much commercial space in the Mill Yard for full re-occupancy of the buildings. Secondarily, from a parking perspective, they could not be reoccupied without significant new parking, at grade or in a new facility. Because of the economic challenges of parking and its impact on the potential for an open space, selective demolition of certain buildings may be appropriate.

Demographic & Market Background

Demographics

- The demographics of Sanford indicate a stable town population, in the midst of a growing York County with increasing educational attainment and growing residential, especially east of I-95 and in and around Portland, ME.
    - The demographics for Sanford area suggest that this area is stable and has stayed in the same population range (less than 1% change) for the last 3 censuses; the 2010 population was 17,589 people losing only 205 people or 1% in that period.
        - By contrast, York County's population was 197,131 in 2010, up 5.6% from 2000.
    - The median income was $42,866 in 2009.
        - York County median income was $54,414.
    - The educational attainment of the households in this area is clustered in the "high school graduate" and "some college" categories, with this population accounting for approximately 85% of the population and approximately 15% with a Bachelor's degree or more.
        - For York County, the group with "some college" or less is 73% with over 27% with a Bachelor's degree or more.
    - However, there has been growth since 2000 in the population of people with college degrees or more, which now make up approximately 15% of the population of the Town, up from approximately 10% in 1990.
    - The Sanford population is relatively old, with the majority of the population 40% in the 35-65 age bracket with significant growth in the 45-55 age groups over the last 20 years.

While demographic trends indicate that Sanford has been stable, it is in a growing county in Southern Maine, experiencing significant in-migration. The information suggests that there is population growth and diversification to be captured by Sanford if a strategy to appeal to these migrants can be crafted.

Residential

- According to Gary Samia and confirmed with other local and web sources, the average cost of a single family in Sanford - South Sanford - Springvale is in the $125,000-$150,000 range. The price is at or below replacement cost for a new single family home.

- In that same discussion, Samia suggested that the condominium market for this area should not be a factor in this analysis at this time; condominium sale prices are lower than their replacement cost.

- Other residential highlights:

- According to Gary Samia, market rental rates for market units in the area are approximately 1BR: $550; 2BR: $750; 3BR: $950.
- As rents in Portland and the area east of I-95 go up, Sanford has traditionally been perceived as a lower cost alternative.
- Fair Market Rents (FMRs) for the area which includes Sanford are: 1BR: $852; 2BR: $1022 and 3BR: $1,488.
- The Sanford FMRs are practically the same as the 60% cap on LIHTC eligible rents (60% of area median income).
  - This suggests that the market for Sanford housing is below the affordable housing eligibility range, which creates an incentive for affordable housing development.
- Consistent with this, Brady Sullivan's project is taking advantage of the proximity of these rental rates to use 4% tax credits to redevelop Mill No.4.

The residential rental market and for sale market is not strong in Sanford, with market and affordable rents in the same area and sales prices for homes in the Town below or just above replacement cost. At these rates, new infill single-family housing is likely not feasible unless land prices are low. It may be more feasible in new subdivisions and more suburban areas. For apartments, there may be feasibility in redevelopment of existing residential properties without subsidy but an adaptive re-use or new construction will likely require subsidy.

Commercial

- Like some other mill towns, Sanford has some vacancy in its commercial facilities, including downtown upper floor offices, and at its industrial park and in the Mill Yard.

- Reviewing recent leases and offering rates for local property, the rate of rent in local commercial space is likely in the neighborhood of $12.00/SF NNN. Based on market data, our sector experience and discussions with local developers, we gather that the rate for new strip retail is likely in the $20/SF NNN range.

- To get a better sense of the commercial user base in the town and what industries they are in, the five largest employers in were the following.

  - #1 Goodall Hospital: 1,000-5,000 employees
  - #2 Pain Management: 500-900 employees
  - #3 Evonik Cyro: 250-499 employees
  - #4 Baker Co.: 100-249 employees
  - #5 Greenwood Center: 100-249 employees

- This suggests that like many cities and larger towns, the leading employer is a medical institution, which can often, through subsidiaries and "clustering" of related industries be a source of growth. This list also indicates that there is strength in the manufacturing sector specifically in the plastics and lab apparatus businesses in which Evonik and Baker operate.

- According to the Brookings Institute Metropolitan Institute analysis of Southern Maine, one of the implications of the region's population and education trends is that based on the growing educational attainment of the region and the proximity to Boston there may be economic development advantages. The analysis featured two companies from Brunswick, and Biddeford in so-called innovation fields such as material science, and referenced the University of Southern Maine and Maine Medical Center. Their study citied these kinds of companies and institutions as places from which there could be regional growth.

- Focusing on the market for the buildings in the Mill Yard, the 2008 appraisal report on the Former Sanford Mills Building at 61 Washington Street identified a price range for mill buildings in the area based on recent competitive sales. This analysis indicated a $4/SF price for local mill buildings before accounting for internal condition. On the basis of a specific analysis of this mill in the Mill Yard, the cost to bring it to a saleable condition exceeded the potential sale price: this is likely indicative of the condition of other Mill Yard Buildings.

Based on this information, the market for retail space appears to be strongest, achieving rents that can drive strip-style development without subsidy. The commercial office and industrial sector is not producing rents in Sanford that could drive new adaptive re-use or new construction without subsidy.

<u>Comparable Cities & Initiatives</u>

To identify redevelopment ideas for re-use of the Mill Yard property, we spoke with officials and consultants working in Lewiston, MA, Holyoke, MA and Pittsfield, MA and reviewed plans for redevelopment in two comparable communities with significant Mill Yards. These cities were selected for comparability to Sanford, in particular because unlike some other successful mill revitalization they have not been able to draw directly from the power of a regional market like metro Boston or the I-495 corridor.

- **Lewiston, ME** is in Androscoggin County, north of Sanford and has a population roughly twice the size of Sanford at 41,592 in 2010. Like Sanford, Lewiston grew in the late 19^{th} century with the Bates textile mills, powered by hydropower from the Androscoggin River in a canal system. After the final mill closed in the 1980's, the City became concerned about how to redevelop the Riverfront Island on which all the mills were located. In the mid-1990's, the City began to work in earnest with local developers to redevelop Mill buildings in the City's Bates Mill complex. Working with the City's support, the developer Tom Platz, was able to attract TD Banknorth and LL Bean into new leased space developed through an adaptive re-use of two of the Bates Mills. According to interviews with town leaders, critical to the success of the redevelopment was the City's commitment to develop large parking facilities as the mills were built out.

This approach has been successful and led to re-occupancy of approximately 500,000 square feet of space.

- **Pittsfield, MA** is a medium-sized city of 40,000 in Western Massachusetts on the Housatonic River in the Berkshires. Once home to a very large GE plant where many of Americas' transformers were built, as the plans closed, the City lost significant population, leaving both vacant commercial mill buildings as well as neighborhoods with significant residential vacancy. Pittsfield has retrenched and worked with Berkshire Medical Center to focus on its role as a regional medical facility and the local museums like MassMOCA to position itself as a leader in arts and culture and the urban center of the Berkshires. Today, much of Pittsfield's downtown upper floors are home to artists and the City has several large art events which along with low rents, have brought many new residents to the City. GLC has worked with the City on plans to demolish vacant residential and create open spaces where the open spaces connect with the river. The critical elements of the model here are the role that the arts focus and residential occupancy play in the revitalization of the City.

- **Holyoke, MA** the City of Holyoke (population 39,880 in 2010) is located along the Connecticut River in western Massachusetts. The City also grew in the later 19th century with the growth of the paper industry, powered by a canal system using Connecticut River hydropower. When the paper industry left the area in the 1960's and 1970's, Holyoke struggled to find a direction for the Mills in its canal district. Recently, a consortium of MIT, UMass-Amherst and Northeastern came together to develop a high-performance computing center in Holyoke powered by the same hydropower source, which is owned by the City. Because the consortium needed significant power to drive its work, which requires computers to make very intensive calculations quickly, the value of having relatively inexpensive power was an attraction. The City has used this initial effort to drive the development agenda in the area, creating a CanalWalk and other public amenities, in hopes that the possibility of clustering with the center and the low costs of the place would attract other businesses and institutional partnerships.

- **Innovation Districts** Recently, a number of influential cities such as Vancouver, BC, Boston, MA and Portland, OR have begun the process of planning so-called innovation districts. These areas are usually long underdeveloped sections of the City. In these cases, the City has designated the Innovation Districts and targeted mixed-use development allowing zoning freedom and other incentives unavailable elsewhere. A frequent target for their build-out is an equal (approximately 30%) mix of a) education or institutional use; b) residential use; and c) private industry use. There is evidence that suggests that areas like this, because of their low relative price point for space and the "clustering" effect of the use mix, have been successful in driven economic growth and redevelopment of vacant real estate. Boston, Cambridge and Holyoke are Massachusetts cities, which in different ways and with different levels of success, are working to create these districts.

The takeaways from these examples are the importance of partnering effectively with development interests, both private and institutional. These comparable cities also feature the critical role of parking in redeveloping a mill building complex; and the potential of providing users with a real competitive advantage like inexpensive power or low rents as an incentive to relocate in a place like Sanford.

<u>Overall Findings & Strategic Direction</u>

- While Sanford does not have all the natural advantages of the eastern side of York County, if the Town and the Mill Yard can create an updated, attractive commercial identity for the Mill Yard, there is population seeking to migrate to York County which could support residential and commercial redevelopment there: the concept of an "Innovation District" should be explored as a leasing strategy and marketing tool.

- Neither residential nor commercial redevelopment in the Mill Yard is likely to be viable without leverage from public subsidy sources. These resources, including Historic Tax Credits, New Markets Tax Credit, TIF and others, need to be identified and aligned with the Mill Yard in advance to encourage development.

- Of these uses, we recommend focusing on commercial use, which appears to meet the direction and intent of the Town.

- Success in the Mill Yard will require partnership: first, with the property owners such as the Fratelli family to make the property available to developers and the Town for redevelopment. Second, the Town needs to identify an approach to locate development interests (private and institutional) to partner with the Town on what will be a multi-phase development effort.

- The parking required for redevelopment of the full complement of space (for example, 1M SF of development would require 2,500-3,000 parking spaces) drives a series of findings. Specifically:

    - There may advantages in selective demolition of buildings with excessive improvements required for redevelopment;
    - The possibility of replacing these buildings with well-designed and located surface parking could support project viability in the remaining buildings and avoid hard-to-source parking facility costs;
    - If the area is to grow into a residential and job center, transportation linkages at the Mill Yard, both locally and regionally should be considered.

- Given residential growth planned with Brady Sullivan and Northland's projects, the Town may want to consider a commercial-led mixed (commercial/retail) re-use of the International Woolens building, the site of the civic plaza discussed in the draft plan.

Next Steps

Assuming there is consensus on these findings, GLC will, on an as-needed basis; support Weston & Sampson in preparing a more specific public-private strategy for the redevelopment; including:

- Sample private development program, including sources and uses of funds;
- Recommended Public Realm investments required to support private / institutional development and applicable sources and phasing (examples are likely to include open space and parking investments described earlier);
- Economic analysis supporting a TIF or related applicable funding sources.

Attachments

Attachment 1: Sample Sources and Uses for Residential and Commercial Re-Use
Attachment 2: Demographic Information, Sanford, ME and York County, 1990-2009

Sanford, ME
DRAFT RESIDENTIAL Land Use Economic Analysis
Sample Based on International Woolens Property
11/1/11

USES			*Notes*
Acquisition/SF	$	-	*Available at Refinancing*
Hard Cost Rehab/SF	$	60	
Soft Cost/SF	$	12	*20% soft costs*
Total Development Cost/SF	$	72	*Assumed Value*
Total SF		300,000	
Total Development Cost/SF		*21,600,000*	
Per Unit		*96,000*	

SOURCES		
Borrowing	8,775,000	*80% Loan To Value*
9% Tax Credit Equity	4,009,500	*See Calculation Below*
State Historic Tax Credit	4,860,000	*See Calculation Below*
Federal Historic Tax Credit	4,104,000	*See Calculation Below*
Sources	*21,748,500*	

REMAINING CAPITAL GAP *(148,500)*

Value Analysis			
Useable Space Ratio		75%	
Total Space		300,000	
Useable Space		225,000	
SF Per Unit		1,000	
Units		225	
Average Rent, 2 BR unit	$	825	*Around 60% AMI - LIHTC Eligible*
Annual Estimated Gross Income	$	2,227,500	
Property Management/Unit	$	6,000	*incl. taxes*
Total Property Management	$	1,350,000	
Net Operating Income	$	877,500	
Capitalization Rate		8%	
Value	***$***	***10,968,750***	
Per Unit	*$*	*48,750*	

Federal Historic Tax Credits		
Eligible Hard and Soft Costs		*$21,600,000*
x Tax Credit Rate		**20.00%**
Total Tax Credit Amt		$4,320,000
x Price	$	0.95
Total Equity Raise		**4,104,000**

State Historic Tax Credits		
Eligible Hard and Soft Costs		*$21,600,000*
x Tax Credit Rate		**25.00%**
Total Tax Credit Amt		$5,400,000
x Price	$	0.90
Total Equity Raise		**4,860,000**

9% Tax Credit Calculation		
Eligible Units		**225**
Annual Allocation Per Unit	*$*	*22,000*
Annual Eligible Tax Credit Allocation	*$*	*4,950,000*
Boost		*1.00*
Tax Credit Rate		*9%*
Annual Allocation	*$*	*445,500*
Tax Credit Period (Years)		10
Total Equity	$	4,455,000
Total Equity Price	*$*	*0.90*
Total Equity Raise		**$4,009,500**

Sanford, ME
DRAFT COMMERCIAL Land Use Economic Analysis
Sample Based on International Woolens Property
11/1/11

USES			*Notes*
Acquisition/SF	$	-	Available at Refinancing
Tenant Improvement Costs/SF	$	50	
Soft Cost/SF	$	10	20% soft costs
Total Development Cost/SF	$	60	*Assumed Value*
Total SF		300,000	
Total Development Cost/SF		*18,000,000*	

SOURCES		
Borrowing	6,750,000	*80% Loan To Value*
NMTC	3,600,000	
State Historic Tax Credit	4,050,000	*See Calculation Below*
Federal Historic Tax Credit	3,420,000	*See Calculation Below*
Sources	*17,820,000*	

REMAINING CAPITAL GAP *180,000*

Value Analysis		
Useable Space Ratio		75%
Total Space		300,000
Useable Space		225,000
Annual Rent PSF	$	10.00
Annual Estimated Gross Income	$	2,250,000
Annual Operating Costs PSF	$	7 *incl. taxes*
Total Property Management	$	1,575,000
Net Operating Income	$	675,000
Capitalization Rate		8%
Value	***$***	***8,437,500***

Federal Historic Tax Credits	
Eligible Hard and Soft Costs	*$18,000,000*
x Tax Credit Rate	**20.00%**
Total Tax Credit Amt	$3,600,000
x Price	$ 0.95
Total Equity Raise	**3,420,000**

State Historic Tax Credits	
Eligible Hard and Soft Costs	*$18,000,000*
x Tax Credit Rate	**25.00%**
Total Tax Credit Amt	$4,500,000
x Price	$ 0.90
Total Equity Raise	**4,050,000**

NMTC Equity Calculation			
Eligible Cost Basis	*$*	*14,400,000*	*Assumes 80% are eligible*
Other Owner Equity	*$*	*-*	
Adjusted Eligible Cost Basis	*$*	*14,400,000*	
Gross NMTC Price (before fees / legal)	*$*	*0.25*	
Total NMTC Equity for Construction		**$3,600,000**	

Social Explorer - Sanford CDP, South Sanford CDP, and Springvale CDP

Statistics	1990 Total		2000 Total		2009 (ACS 5-year estimate)		2010 Total	
SE:T1. Total Population								
Total Population	17,767		17,794		18,661		17,589	
SE:T7. Age								
Total Population:	17,767		17,794		18,661		17,589	
Under 5 Years	1,475	8.3%	1,149	6.5%	1,177	6.3%	1,215	6.9%
5 to 9 Years	1,524	8.6%	1,344	7.6%	1,147	6.2%	1,097	6.2%
10 to 14 Years	1,314	7.4%	1,345	7.6%	1,174	6.3%	994	5.7%
15 to 17 Years	728	4.1%	875	4.9%	684	3.7%	710	4.0%
18 to 24 Years	1,602	9.0%	1,500	8.4%	1,910	10.2%	1,498	8.5%
25 to 34 Years	3,134	17.6%	2,280	12.8%	2,186	11.7%	2,266	12.9%
35 to 44 Years	2,390	13.5%	2,851	16.0%	2,664	14.3%	2,221	12.6%
45 to 54 Years	1,553	8.7%	2,300	12.9%	2,956	15.8%	2,716	15.4%
55 to 64 Years	1,419	8.0%	1,493	8.4%	2,408	12.9%	2,207	12.6%
65 to 74 Years	1,337	7.5%	1,272	7.2%	947	5.1%	1,237	7.0%
75 to 84 Years	903	5.1%	1,009	5.7%	977	5.2%	960	5.5%
85 Years and over	388	2.2%	376	2.1%	431	2.3%	468	2.7%
SE:T13. Race								
Total Population:	17,767		17,794		18,661		17,589	
White Alone	17,313	97.4%	16,981	95.4%	17,569	94.2%	16,580	94.3%
Black or African American Alone	36	0.2%	86	0.5%	233	1.3%	113	0.6%
American Indian and Alaska Native Alone	56	0.3%	61	0.3%	18	0.1%	80	0.5%
Asian Alone	325	1.8%	389	2.2%	380	2.0%	387	2.2%
Native Hawaiian and Other Pacific Islander Alone			3	0.0%	39	0.2%	0	0.0%
Some Other Race Alone			51	0.3%	62	0.3%	57	0.3%
Two or More races			223	1.3%	360	1.9%	372	2.1%
Total Native Hawaiian, Other, and Two+	37	0.2%	277	1.6%	461	2.4%	429	2.4%
SE:T25. Educational Attainment For Population 25 Years And Over								
Population 25 Years and over:	11,111		11,649		12,569			
Less Than High School	3,172	28.6%	2,675	23.0%	2,259	18.0%		
High School Graduate (includes equivalency)	4,461	40.2%	4,844	41.6%	4,776	38.0%		
Some college	2,316	20.8%	2,864	24.6%	3,660	29.1%		
Bachelor's degree	802	7.2%	909	7.8%	1,509	12.0%		
Master's degree			246	2.1%	309	2.5%		
Professional school degree			87	0.8%	26	0.2%		
Doctorate degree			24	0.2%	30	0.2%		
Total master's, professional, and doctorate	360	3.2%	357	0	365	0		
SE:T33. Employment Status For Total Population 16 Years And Over								
Population 16 Years and over:	13,200		13,772		14,966			
In labor force:	8,681	65.8%	8,468	61.5%	9,732	65.0%		
In Armed Forces	99	0.8%	24	0.2%	31	0.2%		
Civilian:	8,582	65.0%	8,444	61.3%	9,701	64.8%		
Employed	7,926	60.1%	8,016	58.2%	9,162	61.2%		
Unemployed	656	5.0%	428	3.1%	539	3.6%		
Not in labor force	4,519	34.2%	5,304	38.5%	5,234	35.0%		
SE:T57. Median Household Income (In 2009 Inflation Adjusted Dollars)								
Median household income (In 2009 Inflation Adjusted Dollars)	$26,056		$32,799		$42,866			
SE:T93. Housing Units								
Housing units	7,384		7,690		8,315			
SE:T94. Tenure								
Occupied Housing Units:	6,748		7,186		7,531			
Owner Occupied	4,090	60.6%	4,309	60.0%	4,234	56.2%		
Renter Occupied	2,658	39.4%	2,877	40.0%	3,297	43.8%		
SE:T95. Occupancy Status								
Housing units:	7,384		7,690		8,315			
Occupied	6,748	91.4%	7,186	93.5%	7,531	90.6%		
Vacant	636	8.6%	504	6.6%	784	9.4%		
SE:T101. Median House Value For All Owner-Occupied Housing Units					Specified and All			
Median value	$89,598		$89,445		$178,373			
SE:T104. Median Gross Rent								
Median Gross Rent	$448		$499		$752			

Note:

Social Explorer Tables: ACS 2005 to 2009 (5-Year Estimates) (SE), ACS 2005 -- 2009 (5-Year Estimates), Social Explorer; U.S. Census Bureau

Demographics, York County, Maine

Statistics	1990 Census		2000 Census		2009 (ACS 5-year estimate)		2010 Census	
SE:T1. Total Population								
Total Population	164,587		186,742		201,306		197,131	
SE:T7. Age								
Total Population:	164,587		186,742		201,306		197,131	
Under 5 Years	12,185	7.4%	11,016	5.9%	10,690	5.3%	10,311	5.2%
5 to 9 Years	12,403	7.5%	13,111	7.0%	11,184	5.6%	11,333	5.8%
10 to 14 Years	11,581	7.0%	14,030	7.5%	13,488	6.7%	12,293	6.2%
15 to 17 Years	6,806	4.1%	8,116	4.4%	8,773	4.4%	8,154	4.1%
18 to 24 Years	14,396	8.8%	12,807	6.9%	16,138	8.0%	15,243	7.7%
25 to 34 Years	29,024	17.6%	23,154	12.4%	21,898	10.9%	20,846	10.6%
35 to 44 Years	26,993	16.4%	32,859	17.6%	29,508	14.7%	26,157	13.3%
45 to 54 Years	16,464	10.0%	28,470	15.3%	34,416	17.1%	33,837	17.2%
55 to 64 Years	13,927	8.5%	17,750	9.5%	26,187	13.0%	28,604	14.5%
65 to 74 Years	11,930	7.3%	13,623	7.3%	15,193	7.6%	16,306	8.3%
75 to 84 Years	6,764	4.1%	8,748	4.7%	10,308	5.1%	9,947	5.1%
85 Years and over	2,114	1.3%	3,058	1.6%	3,523	1.8%	4,100	2.1%
SE:T13. Race								
Total Population:	164,587		186,742		201,306		197,131	
White Alone	162,420	98.7%	182,177	97.6%	195,180	97.0%	190,044	96.4%
Black or African American	555	0.3%	785	0.4%	1,246	0.6%	1,108	0.6%
American Indian and Alaska	329	0.2%	451	0.2%	498	0.3%	603	0.3%
Asian Alone	1,095	0.7%	1,367	0.7%	1,844	0.9%	2,096	1.1%
Native Hawaiian and Other Pacific Islander Alone			59	0.0%	75	0.0%	37	0.0%
Some Other Race Alone			322	0.2%	571	0.3%	512	0.3%
Two or More races			1,581	0.9%	1,892	0.9%	2,731	1.4%
Total Native Hawaiian, other, or two+	188	0.1%	1,962	1.1%	2,538	1.2%	3,280	1.7%
SE:T25. Educational Attainment For Population								
Population 25 Years and over:	107,331		127,591		141,033			
Less Than High School	22,006	20.5%	17,177	13.5%	14,153	10.0%		
High School Graduate (includes equivalency)	38,780	36.1%	44,641	35.0%	48,335	34.3%		
Some college	26,101	24.3%	36,584	28.7%	39,537	28.0%		
Bachelor's degree	14,328	13.4%	19,851	15.6%	26,702	18.9%		
Master's degree			6,784	5.3%	9,165	6.5%		
Professional school degree			1,607	1.3%	1,988	1.4%		
Doctorate degree			947	0.7%	1,153	0.8%		
Total master's, professional, doctorate	6,116	5.7%	9,338	7.3%	12,306	8.7%		
SE:T33. Employment Status For Total Population 16								
Population 16 Years and over:	126,191		145,530		162,747			
In labor force:	87,181	69.1%	99,034	68.1%	111,247	68.4%		
In Armed Forces	1,016	0.8%	589	0.4%	733	0.5%		
Civilian:	86,165	68.3%	98,445	67.7%	110,514	67.9%		
Employed	80,767	64.0%	95,016	65.3%	104,547	64.2%		
Unemployed	5,398	4.3%	3,429	2.4%	5,967	3.7%		
Not in labor force	39,010	30.9%	46,496	32.0%	51,500	31.6%		
SE:T49. Industry By Occupation For Employed Civilian Population 16 Years								
Total Employed Civilian Population 16 Years And Over	80,767		95,016		104,547			
Agriculture, forestry, fishing and hunting, and mining	1,579	1.90%	993	1.1%	1,577	1.5%		
Construction	6,186	7.70%	7,097	7.5%	8,969	8.6%		
Manufacturing	20,964	25.90%	17,670	18.6%	14,045	13.4%		
Wholesale trade	2,480	3.1%	3,796	4.0%	2,824	2.7%		
Retail trade	14,397	17.8%	12,085	12.7%	13,510	12.9%		
Transportation and warehousing, and utilities	4,290	5.30%	3,982	4.2%	3,664	3.5%		
Information	0	0%	1,980	2.1%	1,976	1.9%		
Finance and insurance, and real estate and rental and	4989	6.20%	6,327	6.7%	6,931	6.6%		
Professional, scientific, and management, and administrative and waste	5,405	6.69%	4,818	5.1%	8,154	7.8%		
Educational services, and health care and social	12,387	15.20%	19,598	20.6%	24,170	23.1%		
Arts, entertainment, and recreation, and	703	0.90%	7,515	7.9%	10,298	9.9%		
Other services, except public administration	4,388	5.40%	4,252	4.5%	4,790	4.6%		
Public administration	2,999	3.70%	3,230	3.4%	3,639	3.5%		
SE:T93. Median Household Income in current inflation-adjusted $								
Median household income	$32,432		$43,630		$54,414			
SE:T93. Housing Units								
Housing units	79,941		94,234		103,840		105,773	
SE:T94. Tenure								
Occupied Housing Units:	61,848		74,563		80,423		81,009	
Owner Occupied	44,313	71.7%	54,157	72.6%	60,503	75.2%	59,483	73.4%
Renter Occupied	17,535	28.4%	20,406	27.4%	19,920	24.8%	21,526	26.6%
SE:T95. Occupancy Status								
Housing units:	79,941		94,234		103,840		105,773	
Occupied	61,848	77.4%	74,563	79.1%	80,423	77.5%	81,009	76.6%
Vacant	18,093	22.6%	19,671	20.9%	23,417	22.6%	24,764	23.4%

Note:

Social Explorer Tables: ACS 2005 to 2009 (5-Year Estimates) (SE), ACS 2005 -- 2009 (5-Year Estimates), Social Explorer; U.S. Census Bureau

SECTION 5

RENEWABLE ENERGY

5. ENGAGED COMMUNITY

COMMUNITY ASPIRATIONS:

The Millyard is central to Sanford's sense of place. The Mill buildings are the most prominent feature of the landscape, with the striking pillar of the brick smoke stack visible to all who enter the town**. Identifying opportunities to reoccupy even a portion of the complex will improve the region's self-esteem and people's attitudes toward old industrial buildings**.

PARTNERSHIPS:

Preserving the buildings presents a significant challenge; their massive scale and unmaintained condition make for a complex task. However, saving an endangered industrial heritage will be made easier by **engaging strong partners**. Broad, sustained efforts, combined with creativity will help move the mill buildings off of the endangered list and on to **new roles in which they serve the community** in productive ways. Higher education institutions and healthcare establishments are well-positioned for mutually beneficial relationships with the Town of Sanford and the repositioning of the Millyard.

Throughout the community engagement process, the Sanford Regional Technical Center has been an active partner. Students initiated an effort to measure, draft, and create a scale model of portions of the Millyard to assist in the visualization of alternative futures for development. Previously students from this program had measured, drafted, digitally modeled, and recreated the historic concrete balustrade found along the Mousam River within the Millyard. Most recently, the high school and Technical Center also facilitated student engagement in two design workshop events held in the Middle School library.

COMMUNITY REVITALIZATION:

Historic preservation is an effective down-town economic development strategy. More than ever, cultural and natural assets form the basis for economic development in small communities. The greatest attractions for economic growth in many towns are the **quality of life, natural environment, historic legacy, and cultural context**. **Preserving the character of the Millyard is vital to Sanford's economic competitive edge over other towns in the region and northeast United States**.

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1.0 INTRODUCTION

Weston & Sampson Engineers, Inc. (Weston & Sampson) on behalf of the Town of Sanford, has conducted a Renewable Energy Alternatives Screening to provide the Town of Sanford with data and information necessary to make decisions regarding further detailed studies and/or the possible future implementation of renewable energy systems at the Sanford Mill Yard site.

The following report provides a technology review of commercially viable renewable energy technologies, a site screening for wind, solar, and geothermal system development, and an evaluation of conceptual solar and geothermal systems for the Site. The conceptual project evaluations include required permits, challenges, preliminary project economics, and recommended actions for implementation.

2.0 TECHNOLOGY REVIEW

Renewable energy technologies are generally accepted to include: wind, solar, geothermal, bio-energy, hydropower, tidal/wave or ocean, and hydrogen fuel cell. Renewable energy alternatives are generally more expensive than energy conservation measures, which should be considered first, before implementing a renewable energy technology if the goal is to save money on energy expenditures. This study focused on wind, solar photovoltaic, and geothermal renewable energy technologies available to the Town.

2.1 Wind Energy Systems

The terms "wind energy" or "wind power" describe the technology by which the wind is used to generate mechanical power or electricity**.** In simple terms, wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or an electrical generator can convert this mechanical power into electricity.

Wind turbine generators represent a proven and effective renewable energy technology given proper site conditions and wind resources. Turbines range in size from 2.5 kW to over 3 MW. Small turbines are generally classified up to 10 kW. Small wind turbines are generally mounted atop 20-to 120-foot tall towers using a combination of self-supporting monopole and guyed arrangements. Commercial scale turbines range from 10 kW to 1 MW. Commercial scale turbines are typically used for on-site, behind the meter use. Utility scale turbines are classified as 1.0 MW and larger. The utility scale turbine is typically community or utility-owned and the electricity generated is exported to the grid. Large turbines are commonly mounted on 70, 80 or 100 meter tall towers and can be over 400 feet tall from base to blade tip. The American Wind Energy Association (AWEA) classifies turbines greater than 100 kW as large scale.

A Site Screening for Wind Development at the Site is provided in Section 3.0 of this report. The site screening is provided for a small turbine only. As detailed in Section 3.0 a commercial scale or utility scale wind turbine is not considered practical at the Sanford site. This location lacks sufficient land area and minimum setbacks as required by turbine manufacturers. However, the Site may be suitable for a small wind or micro wind application.

2.2 Solar Photovoltaic Systems

Solar photovoltaic (PV) systems are used to produce electricity. Solar PV systems require unshaded open areas on the roof or ground with preferably a southern exposure. Additional space in an electric room would be required for system components.

Solar electricity supplements existing power from the utility company's grid. PV systems consist of two main components: (1) a number of PV panels and (2) an inverter. The panels convert radiation from the sun into direct current (DC) electricity. The inverter then transforms the DC into alternating current (AC) electricity that can be utilized at the site. A typical PV panel, or module, is approximately 3x6 feet in size or 18 square feet and will generate about 180 Watts (10 Watts per square feet) of electricity under full sun, or enough power to light 10 compact fluorescent light bulbs.

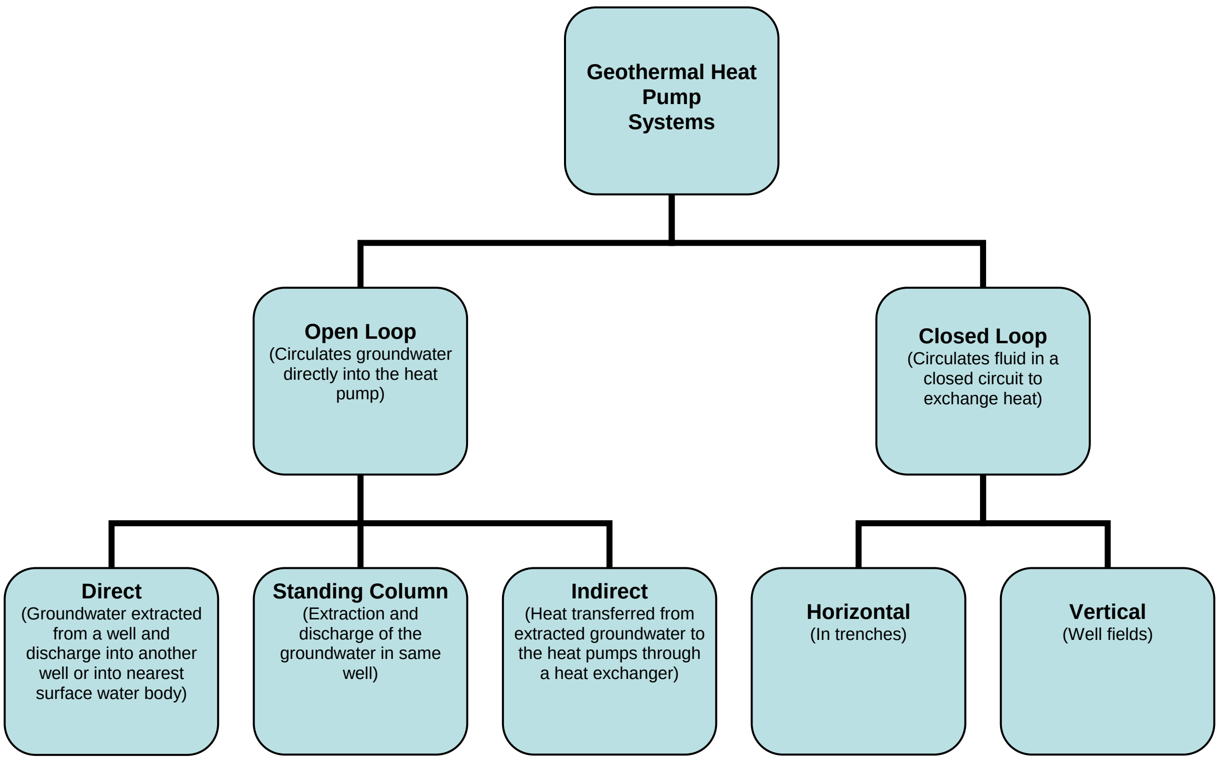
2.3 Geothermal Energy Systems

A Geothermal Heat Pump (GHP) system is a heating and cooling system that takes advantage of the heat stored in the ground. The system operates based on the stability of underground temperatures as the ground, even at modest depths below the surface, has a very stable temperature throughout the year. A GHP system uses the heat available in the winter and puts the heat back into the ground in the summer.

There are two main types of GHP systems: open loop (groundwater heat system pump) and closed loop (ground coupled system). The open loop system has been in use since the 1970's. In the open loop systems groundwater is pumped directly from an extraction well (standing column) to a heat pump where heat is exchanged. After passing through the heat pump the water can be re-injected into the ground using the same extraction well, a dedicated injection well, or into a surface water body. For open loop systems extraction wells are generally deeper (approx. 1,500 feet below surface) than those for closed loop systems (approx. 500 feet below surface) therefore the number of wells to be drilled is lower than in a closed loop system. An open loop system generally provides a high efficiency performance for high heating and cooling demands. Also, water temperatures are generally more stable in deep wells than in shallow wells however, an open loop system usually requires higher pumping power demands due to the depth of the wells and issues with the groundwater quality may need to be addressed. This type of system may require for local/state groundwater discharge permits.

Closed loop or ground coupled systems have been used since the 1980's and are the most commonly used systems. These systems can be installed in either horizontal (trenches) or vertical (wells) configuration. A closed loop system works the same as an open loop system except the water or fluid inside the pipes is contained in a circuit of closed conduits, the water or fluid is continuously re-circulated and never discharged from the piping. Generally there are lower pumping power demands; there is no need to discharge water/fluid therefore permits are not required; and fewer considerations for water quality need to be addressed (e.g. percentage of anti-freeze in the water). Closed loop systems can require larger areas compared to open loop; virgin or undeveloped land may be needed for well fields or a series of trenches. The bigger the heating and cooling demand is the bigger the area required to exchange the heat; Best practices require a minimum spacing between wells of 40 feet.

Alternative systems utilize water bodies such lakes and ponds as heat sink instead of the ground; both open loop and closed loop systems are available for this type of application. The following schematic represents the variation system types.



3.0 SITE SCREENING FOR WIND, SOLAR, AND GEOTHERMAL DEVELOPMENT

Weston & Sampson performed a screening to evaluate the feasibility of installing solar PV systems, wind turbines, and/or geothermal systems. A number of critical factors were evaluated including site characteristics, development factors, development risks, and preliminary economics.

3.1 Existing Site Description

The Sanford Mill Yard area redevelopment site includes an area of approximately 18 acres in the IR zoning district. Figure 1 includes a USGS site location map if the area. The Site is bounded by Washington Street to the West, Pioneer Avenue to the South, Emery Street to the East, and the Mousam River to the North. International Drive bisects the Site from West to East. North of International Drive is an open area which contains a parking lot and an undeveloped area. An aerial location map is provided as Figure 2.

3.2 Wind, Solar, and Geothermal Development Factors

In general, the factors that most often influence the technical feasibility of a wind, solar PV, or geothermal energy project include the quality of the wind/solar/geothermal resource, siting constraints, permitting, energy production, and equipment schedule/lead time. The factors which most often influence the size of the project are cost (i.e. how much money is available for the project) and for wind turbines, height restrictions, which can be limited based on proximity to airports and flight paths and opposition to the sound and visual impacts of the turbine(s). Regardless a GHP system requires a certain amount of electricity to run the pumps that circulate groundwater or fluid in the loop. It may be beneficial to combine a renewable energy power generator such as a PV system to supply power to cover the demand of the GHP system or, to at least significantly lower power cost from the local provider. The following sections discuss these factors in greater detail and relate them to the Site.

3.2.1 Wind, Solar, and Geothermal Resources

As a renewable resource, wind is classified according to wind power classes, which are based on typical wind speeds. These classes range from Class 1 (the lowest) to Class 7 (the highest). Based on review of the National Renewable Energy Laboratory (NREL) Maps, the estimated mean wind speed at the Mill Yard Site is 5.5 meters per second at a height of 80 meters. This wind resource is considered poor for the development of a large scale wind turbine. Smaller turbines generally have lower performance efficiencies than larger machines, and therefore require more robust wind speeds to perform effectively. In addition, surface effects, such as vegetation, on the wind resource can be significant at lower elevations and, therefore, initial screening results of the wind resource at lower elevations must be very favorable to qualify the resource as good. The wind resources at the site are illustrated in Figure 3.

Solar resources for Sanford are moderate at 3.5-4.0 kWh per meter square per day annually. Figure 5 depicts the annual solar resources for the United States. The Town's solar resource is typical of solar resources throughout the northeast.

Geothermal heat pumps throughout the northeast principally rely on the transfer of heat to saturated subsurface deposits. Shallow bedrock conditions at the site indicate heat transfer using ground source heat pumps would be installed in saturated crystalline bedrock. This rock type, illustrated in Figure 4, does not pose a problem for closed loop systems. Open loop or standing column wells may require a minimum water yield if bleed systems are incorporated into the design.

3.2.2 Siting Constraints

In addition to the quality of the wind, solar, and geothermal resource, there are a number of important siting considerations that determine the technical feasibility of a potential renewable energy project. These considerations include: site suitability and setback requirements; construction access and laydown area; aesthetic and environmental impacts; electrical interconnection requirements; subsurface conditions (wind); height restrictions and proximity to airports (wind); panel layout & orientation (solar); and structural analysis (solar). Each of these considerations is addressed in this section.

3.2.2.1 Site Suitability and Setback Requirements

The Town of Sanford bylaw regulates land uses in each zoning district. According to the Table of Land Uses, a wind turbine generator is considered a "prohibited use" in the IR zoning district. Wind generators are allowed as a "conditional use" in the RR, RMU, and IB zoning districts. A micro wind or small wind turbine may be allowed with a variance, but the bylaws do not currently support this use. In addition, the bylaws state that the maximum allowable height in the IR zoning district is 75 feet for both principal buildings and accessory buildings and structures. Any structure over 75 feet would therefore not be allowed in this zoning district. Wind turbine manufacturers generally require a minimum setback distance of at least 1.5 times the turbine height from nearby structures. There is no location on the Site that would allow for this set back from nearby buildings and structures. Due to the zoning restrictions, manufacturer setback requirements, and constructability issues, a commercial scale or large scale wind turbine is not feasible at the Sanford Site.

It was assumed that areas available for PV development would primarily be on the roofs of existing buildings and in the open area north of International Drive. An ideal site will have adequate rooftop area with minimal or no shading. A poor site will have a small rooftop area with many existing roof penetrations and shading issues. For a solar array to work properly it must be placed roughly three times the penetration's height away from the roof penetration. The panels can either be mounted on an appropriate rack system supported by mountings which penetrate the roof, or by non-penetrating mountings held down by ballasts or aerodynamic design. The same site characteristics apply to non-roof top areas. Structures such as buildings and trees are potential shading issues. Racking systems on the ground can be either ballasted or anchored via driving supports into the ground. Further detailed analysis, including a shading analysis, would be required prior to designing a final system. The electrical analysis would determine the location and size of various roof penetrations and the possible effect they would have on a solar PV installation.

Many buildings involved in this study have ample room for the development of solar; however some roofs have “SAW TOOTH” sky lights which would require non-conventional racking systems. It was assumed building 1, 1a, 5b, 5c, 9b and 9C had this type of roof and it would be uneconomical to develop these areas. Shading due to variety in building heights proximity, and penetrations have reduced potential system sizes. It is assumed that shading will occur on building 27 and 28 due to the existing smoke stacks and high number of penetrations. If solar is developed in the Mill Yard area, a detailed shading analysis may be required.

Generally, in order to install a GHP system, there must be adequate horizontal and/or vertical area for system piping installation. Specific considerations for evaluating the economic benefit and installing GHP systems in existing buildings include the building’s energy envelope, internal load density, type of heating fuel used, remaining service life of the existing HVAC equipment, and the ease of converting to a new HVAC system.

3.2.2.2 Construction Access and Laydown Area

A selected site must also be evaluated from a construction and access standpoint. There must be adequate area on the site for construction activities. It appears that there is sufficient area at the Site for equipment storage and construction laydown area. Access to the site from Washington Street or Emery Street appears to be suitable for equipment delivery.

A solar PV or GHP project requires less access and laydown area when compared with a wind project of similar capacity. It appears as if the site has sufficient construction access and laydown area for development of a solar PV or GHP system.

3.2.2.3 Aesthetic and Environmental Impacts

The shadow flicker and sound created by a wind turbine are common aesthetic issues, voiced by residential abutters. Shadow flicker is a phenomenon caused by periodic obstruction of light caused by the rotating blades of the turbine. Shadow flicker depends on site geometry, the locations of potential viewers, blade finish, and the relative sunlight and the operational status of the turbine at any given time on a daily basis. Typically, shadow flicker and noise effects at a distance of 1,000 feet or more are less of a concern; however complaints at greater distances are not uncommon. Shadow flicker and noise are not expected to be constraining issues for a wind project at the Mill Yard site. Shadow flicker and noise impacts can be easily modeled with commercially available software and is usually performed as part of a comprehensive feasibility study including detailed environmental, avian, and wildlife impact studies.

A GHP system does not have aesthetic impacts as the vertical or horizontal loops can be integrated with the landscape architecture of the site with minimal modifications. No significant environmental impacts arise from a properly designed and installed GHP system. Specific permits may be required in case of open loops systems with consideration for the quality and amount of water to be discharged or re-injected (See Paragraph 3.4.2 for Permitting Requirements).

3.2.2.4 Electrical Interconnection Requirements

For a wind turbine project, the electrical loads and proximity to the electrical distribution system load center must be evaluated for a specific site to determine if any extensive electrical infrastructure improvements would be required. The electrical interconnection components ordinarily required to support a wind turbine include lines, voltage transformers, switchgear, breakers and circuit protection. Generally, the further the wind turbine to the point of interconnection, the more expensive the installed cost will be. An electrical interconnection study would need to be performed as part of a detailed feasibility study for a selected site.

For a solar PV project, the existing electrical room must have adequate space to install the necessary components associated with a PV system. Within the electrical room would be installed the DC disconnect switch, DC Transient Voltage Surge Suppression (TVSS), Inverter, AC TVSS, and an AC Disconnect switch. The entire electrical system must be designed to meet the National Electric Code and the Maine Electric Code.

3.2.2.5 Subsurface Conditions

For large scale systems requiring multiple well installations a detailed geotechnical and geological study should be conducted as part of a more comprehensive design study to refine the heat transfer characteristics of the subsurface conditions. The Geologic Map of the Mill Yard area is provided in Figure 4. The subsurface soils at the Site are classified as ice contact deposits. A preliminary review of the 2005 Digital Bedrock Data from the Maine Office of GIS showed that the Town of Sanford bedrock is primarily part of the Rindgemere Formation (Devonian-Silurian) constituted of poorly to moderately well bedded schist and also include the Lyman Pluton formation (Permian-Carboniferous) to the east, primarily composed of granite and pegmatite.

3.2.2.6 Panel Layout & Orientation

For a solar PV project, the panel layout is determined during the design phase. It is beneficial to tilt the PV panels, as opposed to laying them horizontally, in order to achieve better annual output. Tilting the panels also helps to shed snow and dust. Typically it is recommended to tilt the panels at the same angle as the latitude of the site. If it is possible to change the tilt of the panels seasonally, then additional output can be achieved. Depending on the suitability of the site, changing the orientation or panel tilt angle may benefit the system.

3.2.2.7 Structural Analysis

The typical PV system design load is on the order of 5 to 10 psf. In order to install a PV system on a roof, the existing roof would need to have adequate structural support to handle this load or modifications may be necessary. A structural engineer would need to be consulted prior to installation of the system(s).

3.2.3 Permitting Requirements

A review of permitting requirements for Local, State and Federal jurisdictions was conducted as part of the site screening for wind development. Potential regulatory permitting for a wind turbine can be extensive. Typical regulatory permitting on the local level can include: planning board approval; design review approval; variances; and building & electrical permit approvals. Typical regulatory permitting on the state level can include: Maine's Department of Environmental Protection approvals; Natural Resource Protection Act approvals; Bureau of Land & Water Quality approvals; State Historic Preservation Commission approvals; interconnection permitting; and Transportation Department approvals. Typical regulatory permitting on the federal level can include: approvals from the US EPA, Federal Energy Regulatory Commission, Fish and Wildlife Service, and FAA.

As part of the Site Plan Review approval it could be expected that aesthetic and environmental concerns may be raised by any residential abutters. This risk should be anticipated in a wind project that is close to residential properties. The degree of siting opposition would presumably be linked to the proposed turbine size, with opposition rising as the turbine size increases.

For a solar PV project, a building and electrical permit would be required to install solar PV arrays. A building permit is required for any modifications to an existing structure. An electrical permit is required to perform electrical work on or within a structure. The Town does have bylaws regarding height requirements for the selected sites. The maximum height limits are dependent on how each individual site is zoned. Since all the Conceptual PV system Layouts are roof mounted systems, it is anticipated the system will not exceed the Town's height limit of 75 feet. A variance may be required if the maximum building height is exceeded. There are no bylaws specifically regarding installation of a solar PV system. A Design Review and/ Site Plan Review may be required by the Town.

Public Law, Chapter 153 LD 860, item 1, 124th "*An Act Relating to Geothermal Heat Exchange Wells*" of the Maine State Legislature addresses definitions and specifications regarding the licensing of the installers of a GHP system. A system design review and licensing is required by state and local authorities.

3.2.4 Estimated Energy Production

3.2.4.1 Wind Turbine Energy Production

Potential energy production for a wind turbine was not estimated for this study. A commercial scale or utility scale wind turbine is not considered practical at the Sanford

Mill Yard Site. This location lacks sufficient land area and minimum setbacks as required by turbine manufacturers.

3.2.4.2 Solar PV Energy Production

The total conceptual system size for all locations in the Mill Yard Site is approximately 4,035 kW (DC), which is expected to produce approximately 4,475,685 kWh annually. Site locations and conceptual system sizes are included in Figure 6. A summary of array locations, possible system sizes, and estimated annual production are included in the table below.

Array Location	System Size kW	Estimated Annual Production kWh
Building 2	30	32,425
Building 3	115	129,075
Building 3a	5	5,405
Building 4a	60	64,645
Building 4b	60	64,435
Building 5a	240	259,425
Building 9a	90	97,285
Building 9b	65	70,260
Building 28	10	10,805
Ground Mounted Array	1680	1,925,940
Proposed Transportation Hub	1680	1,815,985
TOTAL	4035	4,475,685

Solar PV systems in the northeast United States typically have a capacity factor (efficiency rating) of 10-14%. This capacity factor accounts for seasonal daylight changes, technological constraints and environmental degradation (snow, dirt and dust coverage, etc). With a solar resource of 3.5 kWh/m2/day and an overall system availability of 90% (to account for system maintenance and repairs, grid availability, etc) a capacity factor of 14% was used in this analysis. A panel tilt angle of 10^{o} was assumed for this screening study and a performance degradation rate of 0.5% per year is used in the energy production estimates in this report.

The conceptual system layouts were designed to optimize the areas available for the development of PV systems. The distance between each of the panel rows, for all the conceptual layouts, are approximately 8 feet, which allows no shading to occur between the rows on the shortest day of the year between the hours of 9 AM and 3 PM. This day is chosen as the worst case scenario because the solar azimuth (the angle of the sun to the horizon) is the lowest of this date (approximately 11 at 9 AM and 3 PM). Figure 6 illustrates the conceptual solar PV project layouts at the selected Sites. The conceptual layouts and capacities are based on Yingli Solar Panels, model YL 255 P-32b. Each site layout takes into account the area on the roofs which contain vents, air conditioning units, and other roof penetration which could not be used for solar panel installation. The available roof areas are assumed to be flat membrane roofs, otherwise are slightly sloped corrugated metal or shingled roofs. The buildings with the saw-tooth style roofs were not included in the PV assessment as roof top construction was considered infeasible.

3.2.4.3 Geothermal Energy Production

The required energy production of a GHP system is based on the building's heating and cooling loads. The heating and cooling load is measured in British Thermal Units (BTUs) and is mainly influenced by the building size, number of stories, fenestration, and envelope. BTU units are commonly intended as units of power and translated in "tons of cooling capacity" which is defined as the amount of power needed to melt one short ton of ice in 24 hours; whereby 1 ton is equal to 12,000 BTU/h. Considering that the heat exchange capacity for a closed loop system in a 500 foot deep well is approximately 3-5 tons, whereas a 1,500 feet deep open loop well can provide up to 20-25 tons. A GHP system is typically designed to have the required number of wells and heat pumps to supply the building demand. If the demand varies the system can be adjusted as it's composed of modular units. Moreover, GHP systems can accommodate variation in building demand as they typically have modular configurations with conduit loops to be activate or deactivated as needed to meet demand. GHP system can also be associated with traditional systems (i.e. natural gas of LPG burners) that can be activated during peak demands. A GHP closed loop and open loop schematic is presented in Figure 7.

3.2.5 Schedule/Lead Time

The commercial availability of the solar panels is the main factor driving the timely installation of PV systems. Our experience has shown that in the spring product demand peaks resulting in longer lead times (2-6 months) for delivery of solar panels. Other times of the year, the lead-time for delivery can be as little as one month. Consideration should be given for placing panel orders during off-peak seasons and storing them until construction is underway. Additionally, components such as the inverter or mounting system may be designed and built specifically for the project. A period of 1-3 months should be allowed for this work. Please refer to the Action Plan provided in Section 5 for an estimated project schedule.

Scheduling and equipment lead times for a GHP transfer system are dependent on the size and complexity of the system. Typical design and permitting is estimated to require 60-120 days. Construction including well installation, could range between 90 days to one year.

3.3 Project Development Risks

In addition to the site specific technical challenges mentioned above, there are a number of technical risk factors inherent in wind project development, including wind resource uncertainty, unknown site conditions, permitting uncertainty, etc. There may also be a lack of community support. Historically, many abutters support wind energy projects, however some may have a "not in my backyard" mentality.

One development risk for a solar PV system is the unknown future cost of electricity. If rates fall, then a solar PV system will be less economically beneficial than if electricity rates rise. A detailed solar resource evaluation should be conducted prior to designing and installing a PV system. A detailed evaluation would include an evaluation of nearby structures, roof penetrations, and various roof heights at a facility that may cause shading, and structural requirements for the system.

One development risk for a GHP system is the unknown future cost of oil and electricity. If oil costs fall below that assumed in the rates of return analysis for a GHP system, the return period will be extended; if oil costs rise, the return period will be reduced. If the costs of electricity rise, an additional investment in wind or solar PV system might be beneficial. Other important risk factors that affect the project development are actual ground and groundwater temperatures that are lower than those assumed for system design. In this case, drilling costs might increase due to added drilling footage for deeper wells (open loops) or extra wells to expand the well field (closed loop).

4.0 PRELIMINARY PROJECT ECONOMICS

The preliminary economics will provide insight on the estimated cost of wind, solar, and geothermal projects, and the estimated value of the production, credits and potential incentives.

4.1 Wind Turbine Preliminary Project Economics

For a proposed wind turbine project, the project costs include the following items:

- Engineering studies, design and permitting
- Capital equipment and construction costs
- Interconnection costs (if applicable)
- Financing costs

There are also recurring annual costs associated with a wind turbine project. These annual recurring costs include operation and maintenance, insurance, planned and unplanned service replacement parts, monitoring, reporting, and project administration.

The price of micro wind turbines can range from $600 to $30,000. A micro wind turbine priced at $600 would have a lower capacity than a more expensive turbine. Some micro wind turbines cannot be connected into the electricity grid. This is because the turbine does not have the regulators necessary to make the turbine and grid frequencies compatible .The cost of connecting to the grid in itself can be prohibitive.

Gear-type micro wind turbines can be arranged in rows on the side of a building and costs start at approximately $600. The cost of bigger mast mounted systems is determined by the kind of system, the location, and its size. It is a freestanding system.

4.2 Solar PV Preliminary Project Economics

Solar PV systems costs will vary based on the overall size and layout of the system. Standard industry rates range from $5 to $8 per Watt installed. The estimated project costs for the potential array locations are provided below.

PV System Cost Estimates

Array Location	System Size kW	Initial Cost Estimate		Cost per Watt	
		Low End	High End	Low End	High End
Building 2	30	$150,000	$240,000	$5.00	$8.00
Building 3	115	$575,000	$920,000	$5.00	$8.00
Building 3a	5	$25,000	$40,000	$5.00	$8.00
Building 4a	60	$300,000	$480,000	$5.00	$8.00
Building 4b	60	$300,000	$480,000	$5.00	$8.00
Building 5a	240	$1,200,000	$1,920,000	$5.00	$8.00
Building 9a	90	$450,000	$720,000	$5.00	$8.00
Building 9b	65	$325,000	$520,000	$5.00	$8.00
Building 28	10	$50,000	$80,000	$5.00	$8.00
Ground Mounted Array	1680	$8,400,000	$13,440,000	$5.00	$8.00
Proposed Transportation Hub	1680	$8,400,000	$13,440,000	$5.00	$8.00
TOTAL	4035	$20,175,000	$32,280,000		

The installed cost per kW for a solar PV project tends to decrease as the size of the project increases. There are also grants and rebates that the Town of Sanford may be eligible for. These are summarized in Appendix B and discussed in Section 4.4.

4.3 Geothermal Preliminary Project Economics

Geothermal heat pump system costs will vary based on the size and type of the system. For buildings with considerable BTU, open loop systems are generally less expensive because there are less well locations to be drilled, less extraction wells required resulting in the need for less drilling, trenching, piping, and system connections. The additional cost for a GHP system over a traditional heating and cooling system can range from 25% to 100% depending on the amount of wells or trenching needed. It is important note that a GHP system replaces a traditional heating and cooling system bringing consequent benefits such as lower system maintenance and potential space savings in the building.

An efficient GHP system can reduce energy consumption in the range of 40-75%. According to the EPA, GHP can reduce energy consumption and corresponding emissions up to 44% compared to air-source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment.

As noted previously, the initial investment of this technology is higher than a more traditional alternative e.g. the cost of installation of a GHP system can be as high as twice the average cost of a traditional HVAC system. However, the savings that can be achieved on a yearly base to heating and cooling costs can bring the return time of the initial investment in 10-15 years. Moreover, available federal grants and/or tax credits and the instability of fossil fuel prices are positive factors in reducing the overall investment return time (see Appendix B).

As the renewable energy market is expanding, financial products with innovative strategies to make GHP systems more economically feasible are starting to become more available. One such approach involves a company acting as a third party investor who will cover the costs for the portion of the system outside the building. These initial costs are paid back over time to the third party investor under a “utility like” monthly payment. With this system BTUs are provided at the door under a locked price monthly bill (for more information see www.lvestus.com).

Preliminary analyses of the payback periods for some of the buildings included in the Mill Yard area project are presented in Appendix A. For these analyses, building number 1 and 1a, number 2, number 2a, and number 4 and 4a were selected (see Building Identification Key presented in A1) based on square footage, envelope, fuel type, and heating type. It is important to note that all four buildings selected do not have air conditioning systems. Information on these buildings was collected from the Town GIS reports and the Assessor’s Cards available on the Town website. At this stage of the analysis, capital costs, operation and maintenance costs, and yearly savings are estimated and made under numerous assumptions. However, the return time of the initial investment resulted within a 10-16 years period range. The installation costs to convert from previous heating systems are not included in the initial capital costs; these costs would affect the payback period if significant modifications are required.

4.4 Value of Energy Produced

The primary direct economic benefit of a renewable energy project is the value of displaced retail energy purchased from the grid. The amount of retail energy displaced is a function of the energy produced by the system and the profile of this production as compared to the site’s energy demand and the demand profile. This will vary based on the system installed.

A secondary direct economic benefit of a proposed renewable project is the value of excess energy produced by the system. This energy is defined as energy produced by the system but not used by the site and therefore transmitted to the grid. In Maine, certain renewable energy facilities are entitled to benefit from a practice known as “net metering” in which excess energy sent to the grid is metered and can be used to offset future retail demand. The current legislation dictates the maximum qualifying project size up to 660 kW. The excess energy (kWh) will be credited for up to a 12 month period and can be used at other Town owned facilities (excluding lighting accounts). An alternative to this is to sell the excess energy at a real time rate set by ISO-New England (ISO-NE), typically at a whole-sale rate. ISO-NE is an independent systems operator of the New England bulk power systems.

In addition to the benefits of displaced retail energy purchases and revenues from the sale of excess power, a third revenue stream related to energy production is from the sale of

Renewable Energy Certificates (RECs). RECs were created by the Renewable Portfolio Standards (RPS) legislation enacted over the past several years by several New England states, including Massachusetts. RECs are a tool created to manage and certify compliance with the legislative requirements for power generators to produce a certain amount of their energy from renewable resources. The percentage required is initially very modest, and escalates significantly over the next 5-10 years. Generators that fail to reach the quotas are subject to an alternative compliance payment (ACP) equal to approximately $57/MWh in 2007. RECs are allotted to renewable energy generators at the rate of 1 REC per 1 MWh of production, and these RECs can then be traded on the energy market under the same concept as pollution credits.

Third party ownership is also an option for the Town of Sanford. Many renewable energy installers, especially in the PV industry, take part in third party ownership. In a third party ownership agreement the Town would enter into a long-term power purchase agreement with the third party. The third party would own and operate the renewable energy system, allowing the third party to take advantage of the tax incentives for which the Town would not be eligible as a non-taxable entity. The Town would benefit by purchasing energy at a reduced or fixed cost, lease income, and potentially property tax income on solar equipment. It is typical for the third party developer to have 100 kW as a minimum system requirement. This requirement can be distributed over multiple sites.

Most renewable energy systems qualify for the Community Based Renewable Energy Production Incentive program established by the Maine Public Utilities Commission (PUC). The incentive program provides community-owned renewable energy facilities, including wind and solar, with the opportunity to enter into a long term power purchase agreement (PPA). Excess energy may be able to be purchased at $0.10/kWh. It is assumed that if the Town pursued a smaller sized turbine, such as a 100 kW, any excess energy produced at that facility would be credited to other Town accounts. In Maine, excess energy is sold back to the grid at ISO-NE real time, nodal, rates. It is assumed that rate is approximately $0.045/kWh. It is assumed that excess power produced, not used by Town owned sites would be sold back to the grid at this rate.

5.0 ACTION PLAN

The purpose of an action plan is to detail the tasks and time frames in order to develop and implement a solar, wind, or geothermal project. Development and implementation of municipally owned renewable energy systems can be either standard design-bid-build construction or design/build. This procurement implies that the project will be bought and paid for by the Town as a typical capital project.

Third party ownership is another procurement strategy where the cost of the project is borne by the developer where the Town agrees to enter into a long-term power purchase agreement for the energy that is produced from the system.

These methods for both wind and solar can be seen in the tables below.

Action Plan - Municipal Owned Standard Design-Bid-Build Wind Turbine Project		
Task	*Time Frame*	*Comments*
Feasibility Study	3-6 months	In depth study of potential location of proposed turbine.
Wind Study	12-18 months	MET Tower installation and wind speed monitoring.
Public Outreach and Communication	2-4 months	Hold public meetings/forums for project discussion
Design	4-6 months	Design the site, foundation, electrical improvements, etc.
Permitting	6-12 months	Identify and secure the necessary permits
Procurement	2-4 months	Letters of Intent, Request for Qualifications, Request for Proposals
Bid Evaluation & Selection	2-4 months	Award the bid to the contractor with the best bid package.
Equipment Procurement	12-16 months	Order the equipment and schedule a delivery date.
Construction	6-12 months	May includes site preparation, foundation, turbine erection, electrical improvements, etc.
Interconnection & Commissioning	2-4 months	Test the turbine to ensure it is working properly and connect to the grid.

Action Plan – Third Party Owned Wind Turbine Project		
Task	*Time Frame*	*Comments*
Feasibility Study	3-6 months	In depth study of potential location of proposed turbine.
Wind Study	12-18 months	MET Tower installation and wind speed monitoring.
Engineer Procurement	1-2 months	Hire a consultant for third party engineering oversight.
Procurement	2-4 months	Third Party Owners submit Letters of Intent, Request for Qualifications, Request for Proposals, preliminary design/permitting plan, and draft land lease, and draft power purchase agreement.
Bid Evaluation & Selection	2-4 months	Award the bid to the contractor with the best bid package.
Agreement Confirmation	1-2 months	Sign land lease, power purchase agreement and other legal documents.

Action Plan - Municipal Owned Standard Design-Bid-Build Solar PV Project		
Task	*Time Frame*	*Comments*
Design & Permitting	2-6 months	Design the site layout, system size, electrical improvements, structural checks, etc. and secure necessary permits.
Procurement	2-4 months	Letters of Intent, Request for Qualifications, Request for Proposals
Bid Evaluation & Selection	2-4 months	Award the bid to the contractor with the best bid package.
Equipment Procurement	2-6 months	Order the equipment and schedule a delivery date.
Construction	1-6 months	May includes site preparation, electrical improvements, etc.
Interconnection & Commissioning	1-2 months	Test the system to ensure it is working properly and connect to the grid.

Action Plan – Third Party Owned Solar PV Project		
Task	*Time Frame*	*Comments*
Engineer Procurement	1-2 months	Hire a consultant for third party engineering oversight.
Procurement	2-4 months	Third Party Owners submit Letters of Intent, Request for Qualifications, Request for Proposals, preliminary

		design/permitting plan, and draft land lease, and draft power purchase agreement.
Bid Evaluation & Selection	2-4 month	Award the bid to the contractor with the best bid package.
Agreement Confirmation	1-2 months	Sign land lease, power purchase agreement and other legal documents.

Action Plan – Geothermal Heat Pump with Standing Column Wells System Project		
Task	*Time Frame*	*Comments*
Feasibility Study	1-2 months	In depth study of geothermal type of system.
Design & Permitting	2-3 months	Design of the system, layout of the wells location, etc. and secure necessary permits.
Procurement	1-2 months	Letters of Intent, Request for Qualifications, Request for Proposals
Bid Evaluation & Selection	1-2 months	Award the bid to the contractor with the best bid package.
Construction	2-4 months	May includes site preparation, foundation, turbine erection, electrical improvements, etc.
Commissioning	6-12 months	Test the system to ensure it is working properly; performance monitoring.

6.0 CONCLUSION

Weston & Sampson has conducted a Renewable Energy Alternatives Screening to provide the Town of Sanford with data and information necessary to make decisions regarding further detailed studies and/or the possible future implementation of renewable energy systems at the Sanford redevelopment site. The screening for wind concludes that due to the zoning restrictions, manufacturer setback requirements, and constructability issues, a commercial scale or large scale wind turbine is not feasible at the Sanford Site. According to the Table of Land Uses, a wind turbine generator is considered a “prohibited use” in the IR zoning district. A micro wind or small wind turbine may be allowed with a variance.

Development of a solar PV project appears feasible at 11 locations at the Mill Yard Site. The total conceptual system size for all locations in the Mill Yard Site is approximately 4,035 kW (DC), which is expected to produce approximately 4,4,75,685 kWh annually. Similarly, development of a geothermal heat pump system also appears to be technically feasible at the Mill Yard Site. The required energy production of a GHP system is based on the building’s heating and cooling loads. A GHP system is typically designed to have the required number of wells and heat pumps to supply the building demand. If the demand varies the system can be adjusted as it’s composed of modular units. Weston & Sampson recommends that the Town consider development of Solar PV and GHP systems at the Sanford Mill Yard Site.

7.0 REFERENCES

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Maine. Public Utilities Commission. Electricity Rules; Chapter 65: Independent Agencies – Regulatory; Section 407 Public Utilities Commission; Subsection 315-Small Generation Aggregation. Approved by the Attorney General, September 10, 2004.

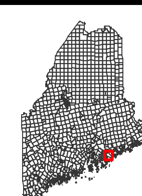
Southern Methodist University of Dallas, Texas, Geothermal Laboratory map funded by Google.org - at http://www.smu.edu/News/2011/geothermal-24oct2011.aspx.

Osberg, P. H., Hussey, A.M., and Boone, G. M., 1985, Bedrock geologic map of Maine: Maine Geological Survey, Dept. of Conserv., scale 1:500,000.

Figures

FIGURE 1
TOWN OF SANFORD, MAINE
SANFORD MILL YARD

USGS SITE LOCATION MAP



Overview Map

Data Source:
Maine Office of GIS (MEGIS)

Horizontal Datum:
UTM Zone 19, Meters, NAD 83

0 1,000 2,000 **Feet**

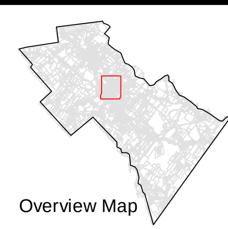
Weston&Sampson

Path: \\gisdatasrv\gis\DataStore\Client\Sanford ME\Project\2110527.B\Fig1_USGS_Map.mxd **User:** laptewip **Saved:** 12/28/2011 2:55:09 PM **Opened:** 12/28/2011 2:55:18 PM

Mill Yard Area

FIGURE 2
TOWN OF SANFORD, MAINE
SANFORD MILL YARD

AERIAL SITE LOCATION MAP



0 1,000 2,000 **Feet**

Weston & Sampson

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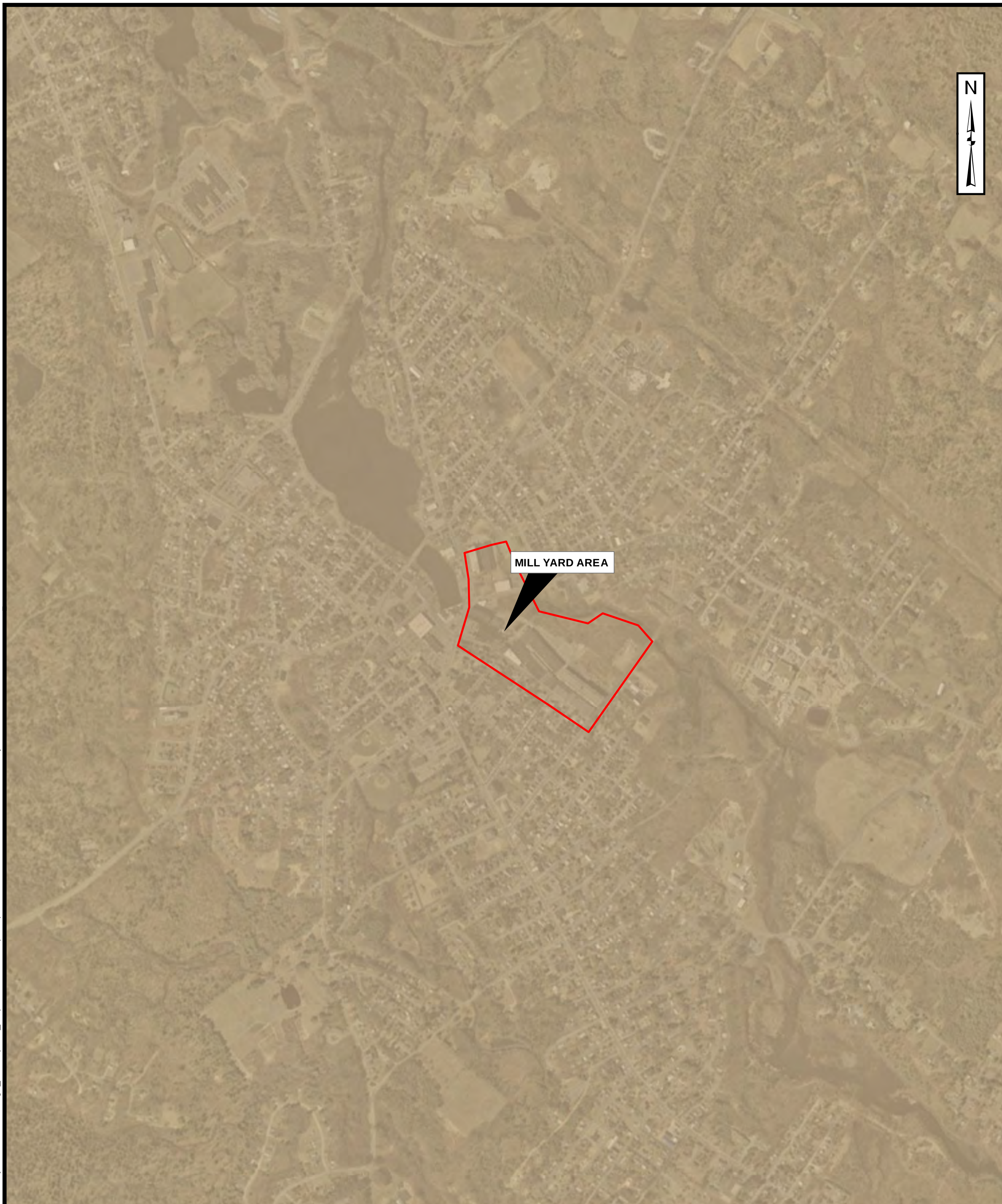


Wind Speed (5.5)

FIGURE 4
TOWN OF SANFORD, MAINE
SANFORD MILL YARD

WIND SPEED 80m

Data Source:
Maine Office of GIS (MEGIS)
National Renewable Energy Laboratory (NREL)

Horizontal Datum:
UTM Zone 19, Meters, NAD 83

0 1,000 2,000 **Feet**

Overview Map

Weston & Sampson

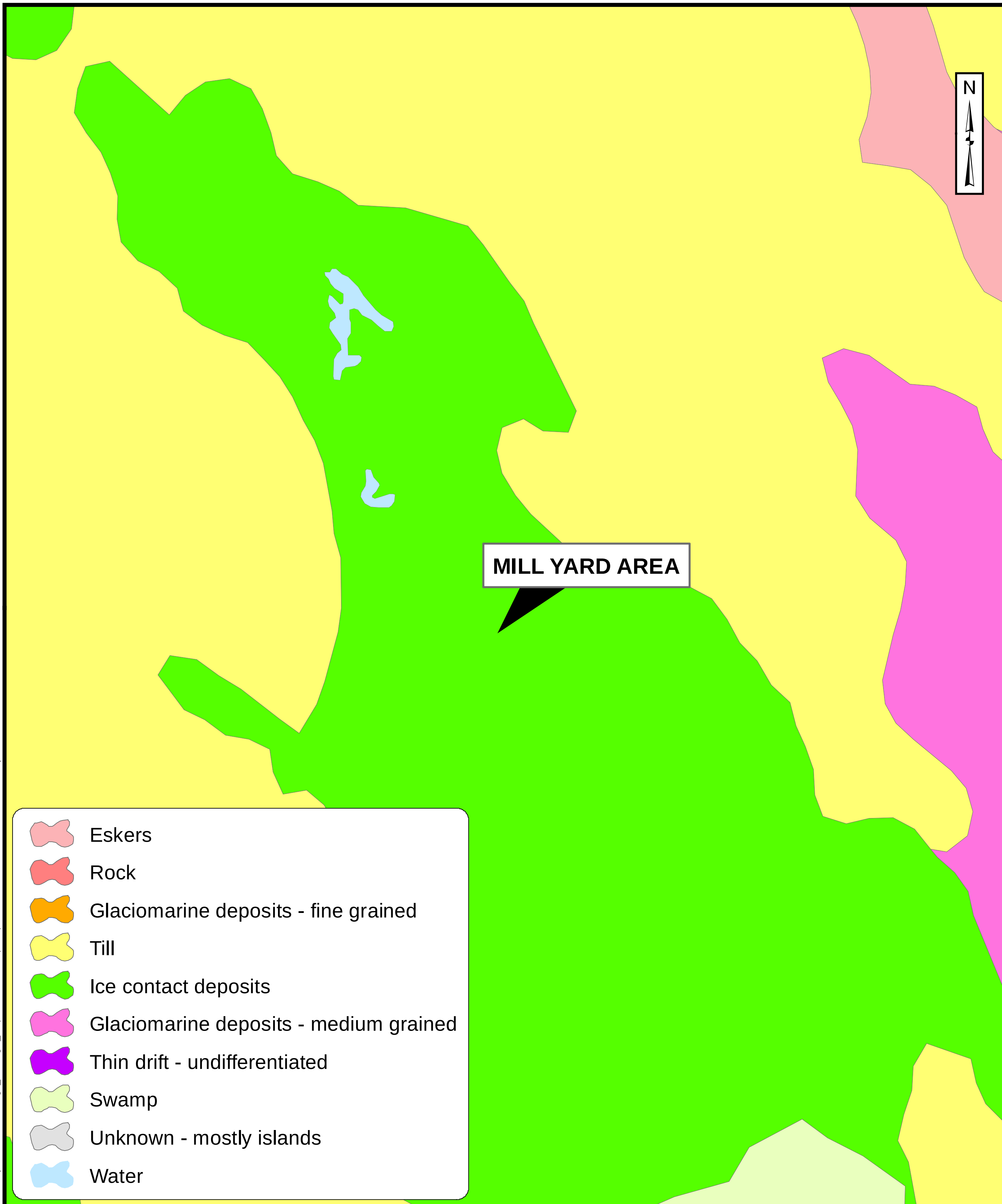


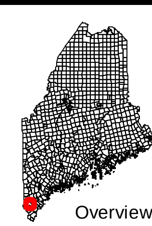
FIGURE 4
TOWN OF SANFORD, MAINE
SANFORD MILL YARD

GEOLOGIC MAP

Data Source:
Maine Office of GIS (MEGIS)

Horizontal Datum:
UTM Zone 19, Meters, NAD 83

0 4,000 8,000 **Feet**



Weston&Sampson

Appendix A

Project Economic Calculations

Appendix B

Summary of Financial Incentives and Rebates

Financial Incentives and Rebates

There are a number of local, state, and federal initiatives and rebates offered for the installation of renewable energy systems. Some of the initiatives that the Town may qualify for are listed below.

The Community Solar Lending Program provides low interest loans to schools for the installation of solar water heating and photovoltaic. Loan rates vary from 0 to 5%.

The Community Based Renewable Energy Production Incentive Program provides long term contracts for energy, capacity resources, or RECs produced by both large (1 MW or greater) and small (less than 1 MW) solar PV systems. The contract price for small solar PV systems is $0.10/kWh. Through the REC multiplier program, RECs are worth 150% of the amount of the electricity, but must be accounted for when they are used to satisfy Maine's Renewable Energy Portfolio Standard.

The Sales and Use Tax Refund for Qualified Community Wind Generators provides refunds for sales and use tax for community wind generating projects that have a nameplate capacity of 10 MW or less.

The Voluntary Renewable Resources Grants provides $50,000 grants for funding of small-scale demonstrative solar thermal electric, solar PV, and wind projects, designed to educate communities on the value and cost-effectiveness of renewable energy. The grants are generally available to schools, and community-based action programs.

The Solar and Wind Energy Rebate Program provides schools and local governments who purchase renewable energy systems rebates. Purchasers of PV systems may qualify for a rebate of $2 per Watt (AC), with a maximum incentive of $2,000. Purchasers of commercial solar thermal systems may qualify for up to 25% of the project cost or $1,000, whichever is less. Non-residential purchasers of wind energy systems may qualify for a rebate of $500 per 500 Watts, up to 4,000 Watts, but not to exceed $4,000.

Qualified Energy Conservation Bonds (QREBs) are issued to finance certain types of energy projects including wind and solar photovoltaic. QREBs are qualified tax credit bonds. The bonds have a theoretical 0% interest rate. The borrower pays back only the principal of the bond, and the bondholder receives federal tax credits in lieu of the traditional bond interest.

Clean Renewable Energy Bonds (CREBs) may be used to finance renewable energy projects including wind and solar. CREBs are issued. The bonds have a theoretical 0% interest rate. The borrower pays back only the principal of the bond, and the bondholder receives federal tax credits in lieu of the traditional bond interest.

The Loan Guarantee Program provides loans to renewable energy projects including wind, solar thermal and photovoltaic, with a focus on projects with a total cost over $25 million. Full payment is required over a period not to exceed 30 years or 90% of the projects useful life.

The Renewable Energy Production Incentive (REPI) provides incentive payments for electricity generated and sold produced by renewable energy systems including wind and solar photovoltaic. Qualified systems are eligible to receive an annual incentive payment of 1.5¢ per kWh in 1993 dollars (indexed for inflation) for the first 10 years of operation.

The Rural Energy for America Program (REAP) Grants provides up to 25% of renewable project costs including solar thermal electric, solar PV, and wind in order to promote energy efficiency and renewable energy.

The High Energy Cost Grant Program provides grants ranging from $75,000 to $5 million to renewable energy projects in communities that have energy costs at least 275% above the national average.

The Business Energy Investment Tax Credit (ITC) is a Federal corporate tax credit applicable to commercial, industrial, utility, and agricultural properties and is equal to 30% of expenditures for solar and 10% of expenditures for GHP systems.

The Residential Renewable Energy Tax Credit is a Federal personal tax credit equal to 30% of qualified expenditures for solar, wind, and GHP systems that serves a dwelling used as residence by the taxpayer.

The Residential Energy Efficiency Tax Credit is a Federal personal tax credit with variable percentage of qualified expenditures including heat pumps, building insulation, windows, doors, and roofs.

The US Department of Treasury – Renewable Energy Grants is a Federal grant program for solar, small wind (less than 100 kW), and GHP systems in commercial, industrial, and agricultural applications. The grant is equal to 30% of the basis of the property for solar and small wind systems; it is equal to 10% of the basis of the property for GHP systems.

Modified Accelerated Cost-Recovery System (MACRS) plus Bonus Depreciation is a federal corporate depreciation incentive which allows businesses in commercial, industrial, and agricultural settings to recover investments in certain properties through depreciation deductions. It includes solar, small wind, and GHP systems and it is available until end of 2012.

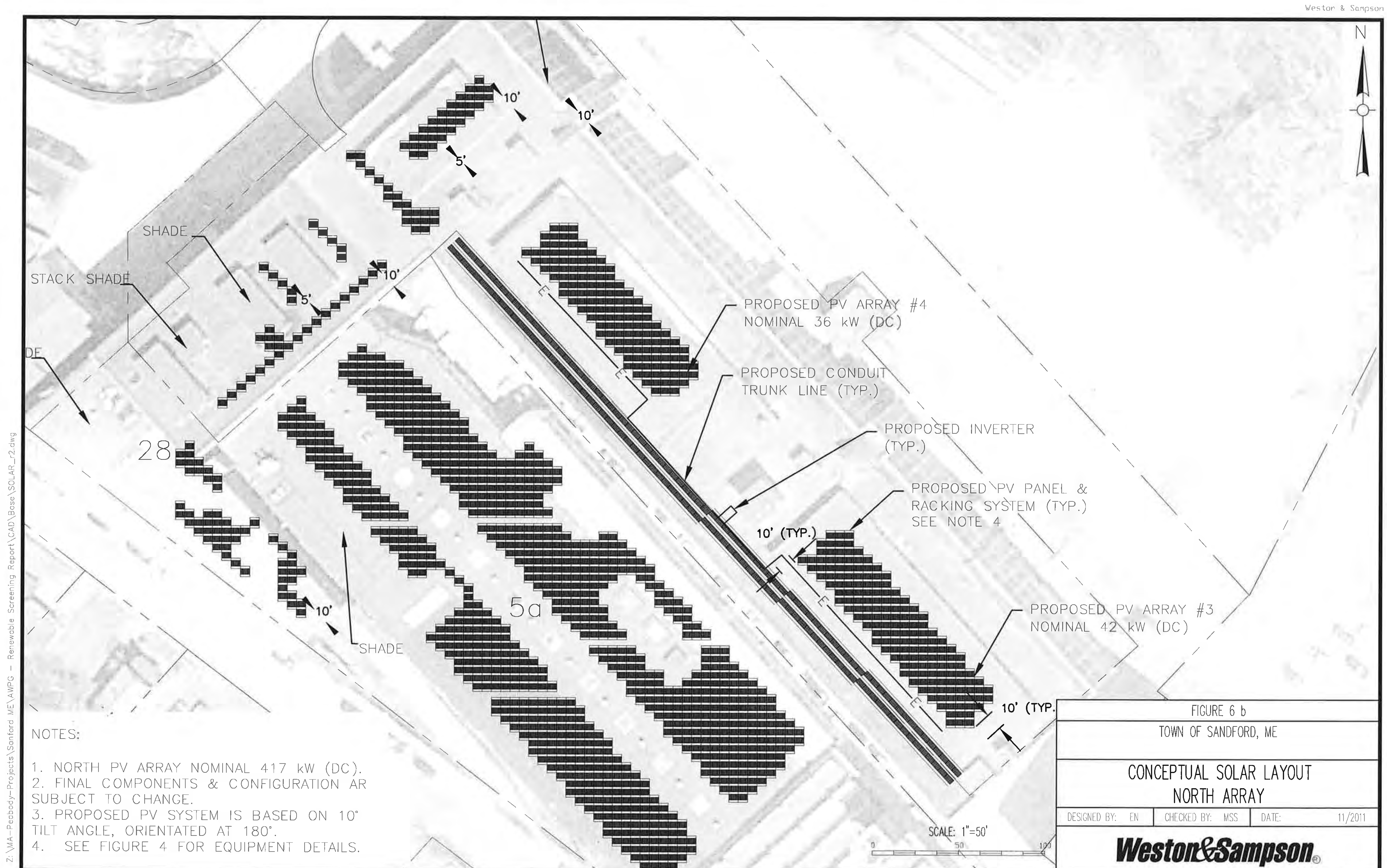
The Local Option – Property Assessed Clean Energy (PACE) of the State of Maine is a financing loan (up to $15,000 in 15 years) under the American Recovery and reinvestment Act (ARRA). Commercial and residential with solar, wind, and GHP are eligible for this financing option.

The Efficiency Maine – Business Program is a state rebate program for commercial, industrial, non-profit organizations, schools, local government, state government, agricultural, and institutional. The rebate includes heat pumps, central air conditioning systems; energy management systems/building controls etc. and is up to 35% of the total cost for retrofit projects and 75% of incremental cost in new constructions, major renovations and replacement of failed equipment.

The Maine PACE Loans are available for residential application of solar, wind, and GHP ranging from $6,500 to $15,000 up to 15 years with a 4.99 fixed interest rate. They include central air conditioning systems, energy management systems/building controls, windows, doors etc.

Appendix C

Selected Material Specifications



Weston & Sampson
N
SHADE
STACK SHADE
DE
10'
10'
5'
10'
5'
28
5a
10'
SHADE
PROPOSED PV ARRAY #4
NOMINAL 36 kW (DC)
PROPOSED CONDUIT
TRUNK LINE (TYP.)
PROPOSED INVERTER
(TYP.)
PROPOSED PV PANEL &
RACKING SYSTEM (TYP.)
SEE NOTE 4
10' (TYP.)
PROPOSED PV ARRAY #3
NOMINAL 42 kW (DC)
10' (TYP.
NOTES:
1. NORTH PV ARRAY NOMINAL 417 kW (DC).
2. FINAL COMPONENTS & CONFIGURATION AR SUBJECT TO CHANGE.
3. PROPOSED PV SYSTEM IS BASED ON 10° TILT ANGLE, ORIENTATED AT 180°.
4. SEE FIGURE 4 FOR EQUIPMENT DETAILS.
SCALE: 1"=50'
0
50
100
FIGURE 6 b
TOWN OF SANDFORD, ME
CONCEPTUAL SOLAR LAYOUT
NORTH ARRAY
DESIGNED BY: EN
CHECKED BY: MSS
DATE: 11/2011
Weston&Sampson
Z:\MA-Peabody-Projects\Sanford ME\AWPG - Renewable Screening Report\CAD\Base\SOLAR_r2.dwg

SECTION 6

RECREATION, HEALTH, AND WELLNESS

6. IMPROVED HEALTH

HEALTH AND WELLNESS:

The design of the physical environment has a crucial and positive influence on improving public health. **The redevelopment of the Sanford Millyard and surrounding open space network will create new opportunities for daily physical activity and represents a promising strategy for pursuing environmental change in Sanford's downtown**.

THE LANDSCAPE:

The Millyard is well positioned to advance health and wellness in the region in the following ways:

1. Through the **remediation of Brownfield Sites** into active and passive parkland.
2. Through an engineered riverbed that creates "**Number Two Pond**" with opportunities for water-based, year-round recreation from kayaking to ice skating.
3. Through the development of an inviting and accessible **Riverwalk** that connects to the broader **trail network** as a hub destination for hiking and biking.
4. By providing a **unique outdoor environment** that supports civic events and becomes a draw for visitors and tenants of the Millyard alike.
5. By **attracting tenants** who are associated with health and wellness and would benefit from the association.

The design of the trail network will promote physical activity and increase community awareness of the benefits of active living. The Riverwalk and Number Two Pond will increase opportunities for physical activity by extending the existing trail system that **enhances linkages with adjacent neighborhoods** and creates a culture where walking and biking are preferred over driving. Regional events like triathlons and road races perpetuate fitness and healthy living as an inherent part of living in Sanford. A more robust open space network can also influence the policies and partnerships that support active living in Sanford and York County.

GOODALL PARTNERSHIP:

A potential partner in this theme for the revitalization and health of the Millyard is Goodall Hospital. As the town's largest employer, there are partnering opportunities to collaborate with the region's primary health care facility. The hospital is less than a mile from the Millyard. Focusing on health, wellness, and recreation align with the hospital's core mission.

HEALTH and WELLNESS

Leveraging Health and Wellness through the repositioning of the Millyard

The Millyard in Sanford is central to the community's sense of place. The Mill buildings are the most prominent feature of the landscape, visible to all who enter the town. Identifying opportunities to reoccupy even a portion of the Mill complex will improve the region's self-esteem and resident's attitude towards old industrial buildings.

One of the goals in repositioning the Millyard is to create an environment that **provides opportunities for a healthy lifestyle** and can support active living behaviors. The design of the physical environment has a crucial and positive influence on improving public health. The redevelopment of the mill buildings and surrounding parkland will create new opportunities for daily physical activity and represents a promising strategy for pursuing **environmental change** in downtown.

ACTIVE DESIGN:

Active design is environmental design that encourages stair climbing, walking, bicycling, transit use, active recreation and healthy eating. Active Design promises benefits not only for public health, but also for the physical environment and advancing aspects of universal design for people of all ages. Design strategies that increase physical activity and improve health also **enhance environmental sustainability** by reducing energy consumption and greenhouse gas emissions.

LANDSCAPE:

The Sanford Millyard is well positioned to advance health and wellness in the region in the following ways:

1. Through the remediation of brownfield sites into active and passive parkland;
2. Through the formulation of "Number 2 Pond" and the associated Riverwalk;
3. Through connections to the broader network of trails;
4. By attracting tenants into rehabilitated Mill spaces that are associated with health and wellness and would benefit from the association.

The design of the trail network will promote physical activity and increase community awareness of the benefits of active living. The Riverwalk and "Number Two Pond" will greatly increase opportunities for physical activity by connecting with the existing trail system with a continuous network of running and walking trails that enhance linkages with adjacent neighborhoods. A more robust open space network can also influence the policies and partnerships that support active living in Sanford and York County.

MILL BUILDINGS:

The reoccupation of the buildings themselves, in addition to remediation of the landscape, can also help to rebrand the site as a place of wellness. Rebranding the Millyard as place of health and wellness targets specific niche tenants that would not otherwise look to locate in Sanford. Organic food producers, recreation retailers and health-related partners can begin to build on the concept and create synergies between them.

GOODALL PARTNERSHIP:

An important partner in this theme for the revitalization of the Millyard is Goodall Hospital. As the town's largest employer there are **many partnering opportunities to collaborate with the region's primary health care facility**. The hospital is also located a half mile from the Millyard. Focusing on sustainability, health and wellness and recreation align well with the hospital's core mission. Like the hospital is today, the Millyard was once a source of pride for the community with a concentration of employment opportunities and contributing to the economic vitality of the region. These opportunities can emerge again in the Millyard's reoccupation. The hospital should have a presence in the Millyard as they are already a major part of the town's identity and carries a positive reputation and association with the Sanford's origins.

While the hospital likely needs to keep mission-critical programs on campus, Goodall has some departments which could possibility be located within the Millyard. Occupational Health or the Rehabilitation Department, for example, could be viable candidates as these programs operate with some autonomy and may benefit from being located along trails and the emerging Mousam Riverwalk. There is some outmigration already occurring for the hospital, with patients going to Kennebunk as the hospital is short on space in its current location. Ideally, having some hospital programs within the Millyard **reinforces the perception of the hospital being a part of the community** "fabric".

TRANSIT:

Research shows that particular features of the built environment, such as the availability and quality of parks, the condition of sidewalks and the proximity of commercial destinations influence a person's decision to walk or use active transportation. The construction of the

Sanford Transit Center (STC) is an added benefit for the Millyard's redevelopment. It will enable more people to access the area and create a multi-modal destination for pedestrians, bikes and buses. While the exact location for the STC is still undetermined, its proximity to downtown and adjacency to the Mill complex will allow for greater connectivity.

NEXT STEPS:

- Presentation to the Goodall Hospital's Board of Directors or Executive Committee on potential partnering opportunities;
- Coordination with the region's Department of Health and/or community health foundations;
- Creation of a Town-wide Bicycle and Pedestrian Advisory Board;
- Exploration of incentives for fresh food financing initiatives in the region;
- Infrastructure assessment to determine necessary road and sidewalk improvements;
- Identification of necessary changes to the physical environment to make it more walkable such as the installation of countdown timers, high-visibility crosswalks and speed-limit signage;
- The development of new programs and/or events to promote active living (such as a fitness fair, 5k run or "Millman" sprint triathlon;
- Application for technical assistance for the National Park Service "Rivers, Trails and Conservation Assistance Program.

The Millyard is a resource to be reused, regenerating the community and offering opportunities to reinforce Sanford's cultural identity. Looking towards health and recreation as a potential niche market will create new economic development prospects and increase employment. Engaging strong partners like the hospital and local community foundations is critical towards moving the industrial heritage of the Millyard off of the endangered list and on to new roles in which they serve the community in productive ways.

End of notes 1/26/12 DG

PLANNING AND DESIGN

1. EXISTING OPEN SPACE AND LANDMARKS

The scale of the Millyard dwarfs the scale of the downtown, although the topography of the site helps to diminish the difference. The relationship between Main Street and the Millyard can be enhanced with the reoccupation of the Mill buildings and the remediation of the land around the site.

2. EXISTING BUILDING IDENTIFICATION / KEY

The Millyard grew incrementally over time. Individual buildings were identified by numbers (1-9).

3. EXISTING PROPERTY OWNERS

One of the biggest challenges in the rehabilitation of the Millyard centers on the fact that there are multiple property owners. Each building is in a different state of occupation, with some structures currently in use, such as the Surplus Supply Mill, while others have been vacant for a generation or more such as the International Woolen Building. The Sanford Mill is in the process of being converted into housing and retail space, and represents the first reuse in the district. The fate of the largest residential project in the Millyard (Stone and Stone) is unclear, but the more residential uses there are in the area the more vibrant a place it will become.

4. DISTRICT CONCEPT MAP

The EPA Brownfield Area-wide Plan for Sanford is somewhat unique amongst Area-wide plans in the Northeast in that the Pilot Project involves both a remediation strategy for the property surrounding the Millyard as well as a reuse strategy for the vacant buildings of the Millyard themselves. The District Map recognizes this confluence by identifying two overlapping geographies: **the "Millyard" and the "Riveryard"**.

The Riveryard encompasses the area around the Mousam River to the north of the buildings and Heritage Way, formerly known as International Drive. It provides a boundary for a **new**

Riverwalk and an area of intervention for dealing with the most toxic properties. The Riveryard enables an **extension to the existing trail network** and establishes a river transportation hub where the public can access the waterway with canoes. **Number 2 Pond**, in the approximate center of the Riveryard, is a **wetland and water purification strategy** to accommodate stormwater runoff for the complex. The new water body will fluxuate with the seasonal changes in water flow and provide an educational and recreational venue for the entire region.

The geographies of the Millyard and the Riveryard overlap in **the Courtyard**. The courtyard is the gathering place for the entire complex, and the one space that links the major property owners together. Although less than two acres in size, the Courtyard will be the primary public space in the Mill District. The Mousam River drops in elevation within this plaza, and the white noise of the rapids will be a wonderful backdrop for future festivals and events.

The **three yards of the plan**: the Millyard (that encompasses the buildings themselves), the Riveryard (natural landscape), and the Courtyard (where the two overlap), help to differentiate approaches to environmental remediation and the various degrees of intensity of use.

5. PROPOSED CONNECTIVITY AND LANDMARK SYSTEM

Revitalization of the Millyard will be a catalyst for redevelopment in the downtown. New residential, retail, entertainment and cultural tenants will complement existing venues. The Courtyard of the complex, which is envisioned as a hard and soft space akin to a European plaza, will be the center of activity for this incremental revitalization. New uses will be attracted to the area over time and as vacant space in the complex becomes occupied. Nearby, the **Sanford Transit Center** site (at the intersection of Washington Street and Riverside Avenue) will activate this block of the Midtown Mall and assist with filling in the gap that has existed in the urban fabric.

Bodwell Street, currently nothing more than a tertiary neighborhood street, takes on new significance in the Area-wide plan as it connects the Courtyard to the City's Main park space at

Main Street and City Hall to the south. The **Administration Building** of the International Woolen Building is the portion of the complex which is most likely to be rehabilitated due to its modest size (approximately 7,500sf over three floors) and relatively good condition. It also occupies a key strategic location within the complex and is a focal point within the courtyard. **The stairway** that leads from the Wasco building on Pioneer Avenue serves as both a threshold in to the complex and a gateway into the neighborhood.

Redevelopment of the Stenton Trust buildings would be made more likely if they were seen as integral to the Millyard and not as industrial outliers. The creation of a new **traffic circle/round-about** at the intersection of High Street, Washington Street and River Street will help to overcome the awkward intersection that exists and bring enable stronger connections. A new mixed use building is sited along River Street, helping to better integrate the Stenton Trust buildings into the Millyard. Marginalized and industrial uses at the river's edge are replaced with well-landscaped open space.

6. PROPOSED AREA-WIDE PLAN

The Brownfields Area-wide Plan for Sanford integrates **environmental remediation, renewable energy, rehabilitated infrastructure and economic revitalization**. Each component helps to reinforce the other. The large project site creates exciting opportunities to harness, capture and store the site's natural energies through geothermal and solar power. These two strategies offer the most potential to decrease reliance on traditional fuel sources and to assist in the rebranding of the Millyard from a highly contaminated site into a sustainable and environmentally-sensitive destination. The photovoltaic fields will be implemented in phases with rooftop installations and in a solar array within the Riveryard. Geothermal heat pumps are placed below grade and will also be implemented in phases, coming on line as large tenants vie for space in the Mill buildings.

Environmental remediation strategies will vary depending on the type of contaminants and the degree of degradation. Additional testing is needed on specific properties to identify appropriate levels of intervention. However, regardless of the remediation strategy used (cap, remove or a combination of both), the Riveryard area creates an area of intervention that extends the open space system and connects to the existing assets of the town with Number One Pond and the Trail network. The Riveryard - as a new recreational and environmental asset to the Town - will signal to the community that this landscape is an amenity, and not a liability, and enable public access to areas of the complex that have been inaccessible.

7. HYPOTHETICAL PROGRAM DISTRIBUTION

The most viable approach to reoccupation of the Millyard, and a proven approach to urban redevelopment in general, is to seek out a mix of nontraditional uses that creates a synergistic vitality. This is particularly important in cities or districts with less than robust market demand. This strategy begins to "reposition" a property or a district as an interesting destination. This does not mean developing a market plan for huge amounts of available space, but rather to **begin with reasonable chunks** that begin to animate a property and lead to new interest over a period of time for remaining space. In essence, to build value through **a series a viable developments** that create both **traffic and interest**. This more often than not requires a collaboration - as opposed to a negotiation - between the public and private interests to create a partnership with complementary and mutually supporting goals.

Therefore, the economic focus is on a **micro development strategy** specifically related to this property and the activation of Sanford's Millyard and downtown. This tactic seeks out those possibilities which can **build value and generate a more positive image** for the area over a period of time.

The redevelopment of the Millyard will be a long term effort, and early catalytic actions that can jump-start activity and interest should be prioritized. Actions in which the Town and/or other public sector actors can influence and leverage early activity should be pursued aggressively. Examples of such potential leveraging actions include the location of an **Educational component** such as Vo-Tech programs or certain components of the High School.

Location of these uses in the Millyard can provide richness to these schools and signal to potential private businesses and tenants that the community supports the Millyard revitalization.

Partnerships with the **Medical and Research** community also need to be pursued as these can be long term tenants who benefit from open floor plans and flexible layouts that can grow with increased demand. As the Millyard has a long standing tradition of fabrication, small scale medical device manufacturers may be enticed to locate there. **Industrial** manufactures who are looking for inexpensive and open spaces may also be early tenants in specific sub-areas of the Millyard.

Health and Wellness uses are intergenerational, offering programs for people of all ages and represent an untapped market for Sanford. While the YMCA is undergoing expansion nearby, the Millyard can become a destination for such uses and assist with the rebranding of the site. These uses complement more traditional uses such as retail, residential and commercial tenants and create a vitality that will ultimately lead to a more successful destination.

7b. **HYPOTHETICAL TENANTS/USERS**

Outreach to targeted business and industry niches needs to be pursued once there is clarity on the Millyard Brand. This map demonstrates a hypothetical distribution of tenants based on the concepts of **Sustainability, Health and Wellness and Outdoor Recreation**, and attracting existing business who are successful, local, and who may be attracted to locate in the Millyard

BODWELL CONNECTION AND RIVERWALK

The remediation of the land along the Mousam River provide an opportunity for active and passive recreation in areas which were previously not accessible to the public. A new Riverwalk, running parallel to the river on both sides, creates an extension to the town's trail network. Bodwell Street is an ideal corridor that links the Courtyard of the Mills to the Town's primary square.

OVERLAY OF HISTORICAL WATERWAY SYSTEMS

An overlay of the historic alignment of the Mousam River reveals that the area to the north of the Millyard was historically a waterbody. This was made possible by the two dams to the west. The area surrounding the Mousam River in this location is now not publically accessible. In addition, overhead transmission wires run across the site, further diminishing the attractiveness of the landscape.

CONCEPT EXPLORATION A, B

The relationship between the Mousam River and the land on either side offer design opportunities to enhance the identity of the area. Remediation strategies for dealing with the contaminants will inform the appropriate design response.

CONCEPT EXPLORATION SECTIONS

The Riverwalk path has the potential to change in character as the river itself moves through the Millyard. The Mousam has three different edge conditions: the natural edge along Number one Pond, a more urban and defined edge through the Courtyard, and a sloping gradation within the Riveryard leading to Number Two Pond. While the material palette of the riverwalk may be consistent along its length, there are opportunities for variation in the section that can enhance the connection to the water.

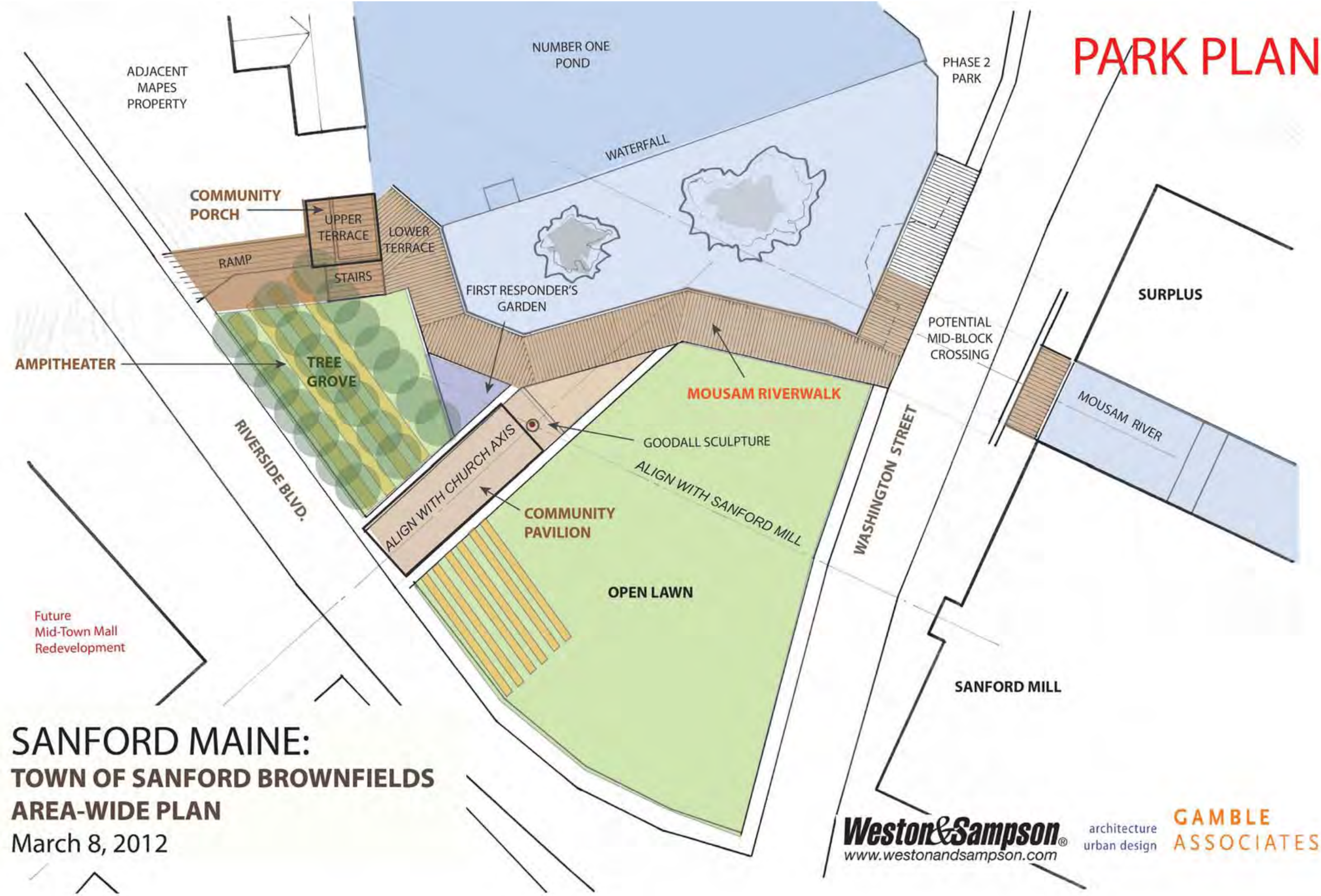
TRAIL MAP

Sanford is well known for its recreational trails. The Area-wide Plan builds on this asset by extending the trail network into the site and enhancing the reputation of the area as a place of recreation, health and wellness. Sanford can be seen as a recreational destination to a regional outdoor environment with the Millyard acting as both a destination and gateway to the larger system.

SECTION 7

IMPLEMENTATION

PARK PLAN



SANFORD MAINE:

TOWN OF SANFORD BROWNFIELDS AREA-WIDE PLAN

March 8, 2012

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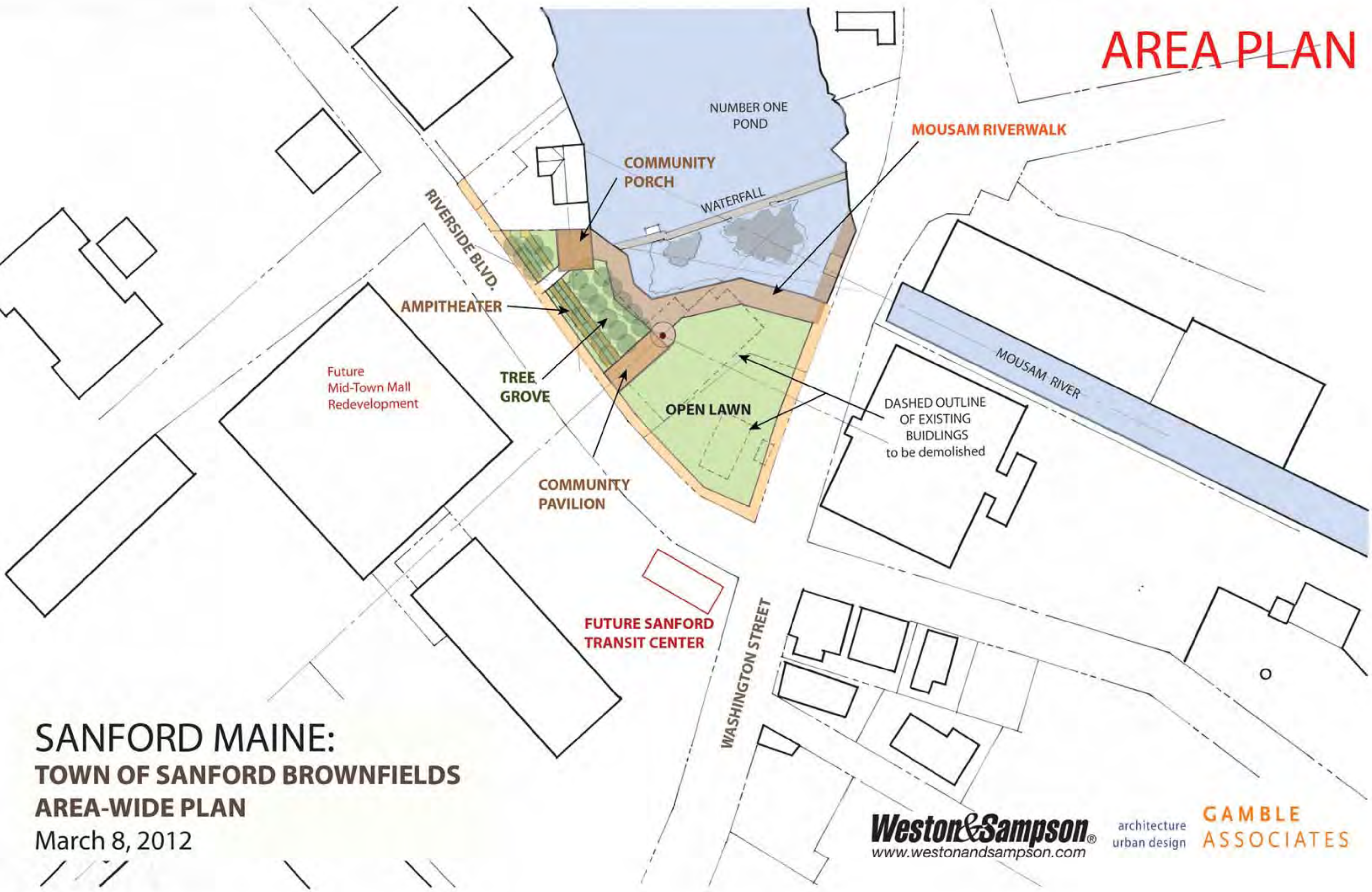

SANFORD MAINE:

TOWN OF SANFORD BROWNFIELDS AREA-WIDE PLAN

March 8, 2012

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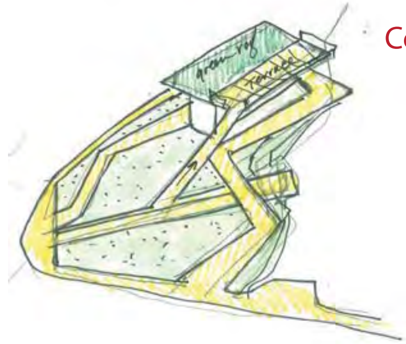
CONCEPT




Concept sketches

BIRCH GROVE

BUS SHELTER

COMMUNITY PAVILION

FALLS OVERLOOK

RECOMMENDED BUILDING PRINCIPLES

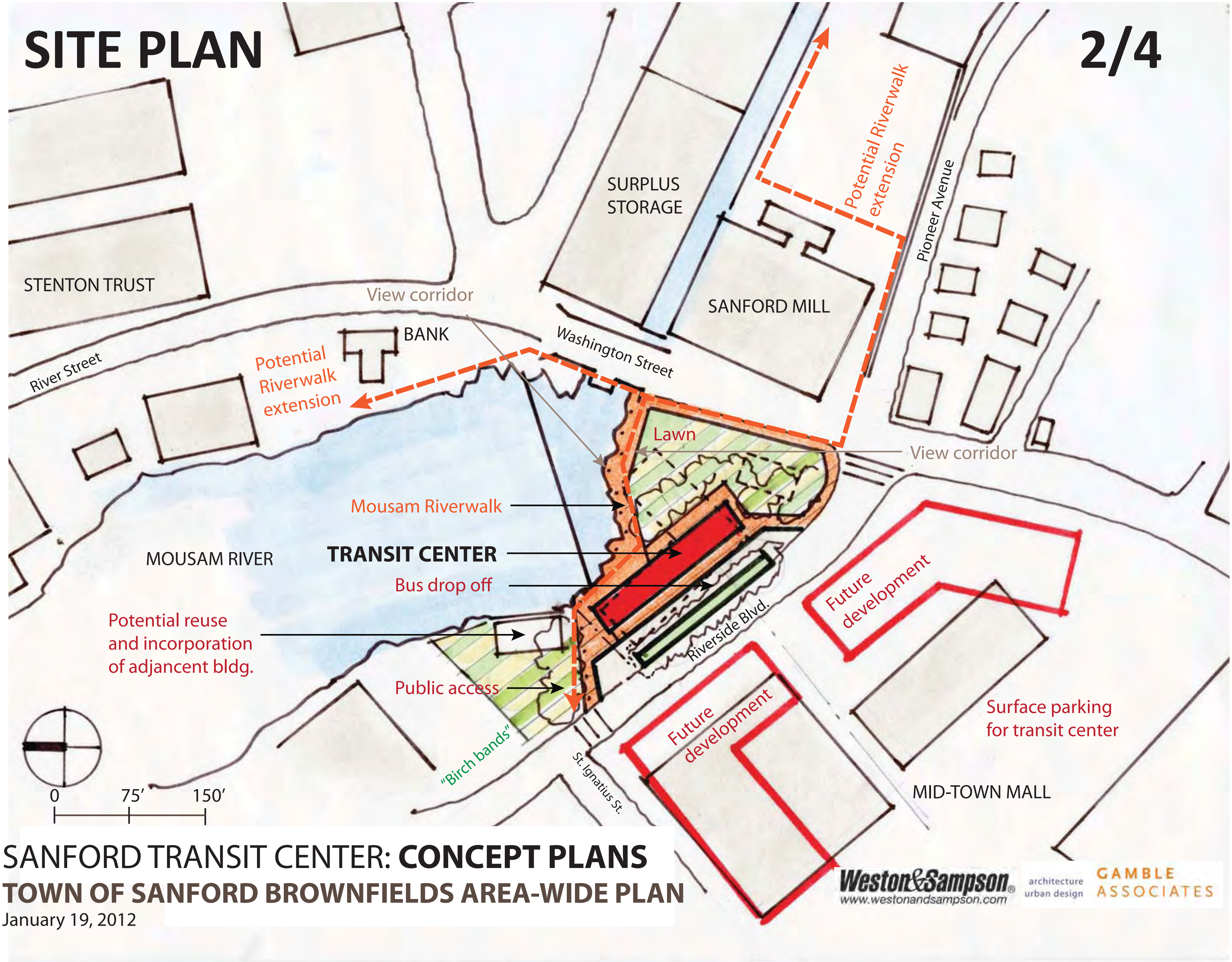
1. SCALE: While the building itself is little more than a pavilion at 1,500sf, the roof should be more impressionable, serving to add a *civic importance* to the building and also provide cover for the buses. The concept is to make the overall structure of the Sanford Transportation Center larger than the modest program it contains.

2. BUILDING SETBACK: The building should not be placed up to the Riverside Boulevard street edge. Rather, the building should be setback from the street with a wide median that separates cars from buses. The landscaped median separates the road from the drop off and enhances pedestrain activity.

3. ORIENTATION ON SITE: The orientation of the building should be parallel to Riverside Boulevard and the River. The waiting area should actually look out onto the falls, so as people wait they could view the falls and riverwalk. When the floor plan is elongated (not square), the interior space captures more view along the Riverwalk.

4. OPEN SPACE: The corner of the site at Washington Street and Riverside Boulevard should remain open, so that the view of the falls is apparent as one drives away from Main Street and towards the Mousam River. A grove of native birch trees envelope the building and relate it to the history of the area.

SITE PLAN



SANFORD TRANSIT CENTER: **CONCEPT PLANS**

TOWN OF SANFORD BROWNFIELDS AREA-WIDE PLAN

January 19, 2012

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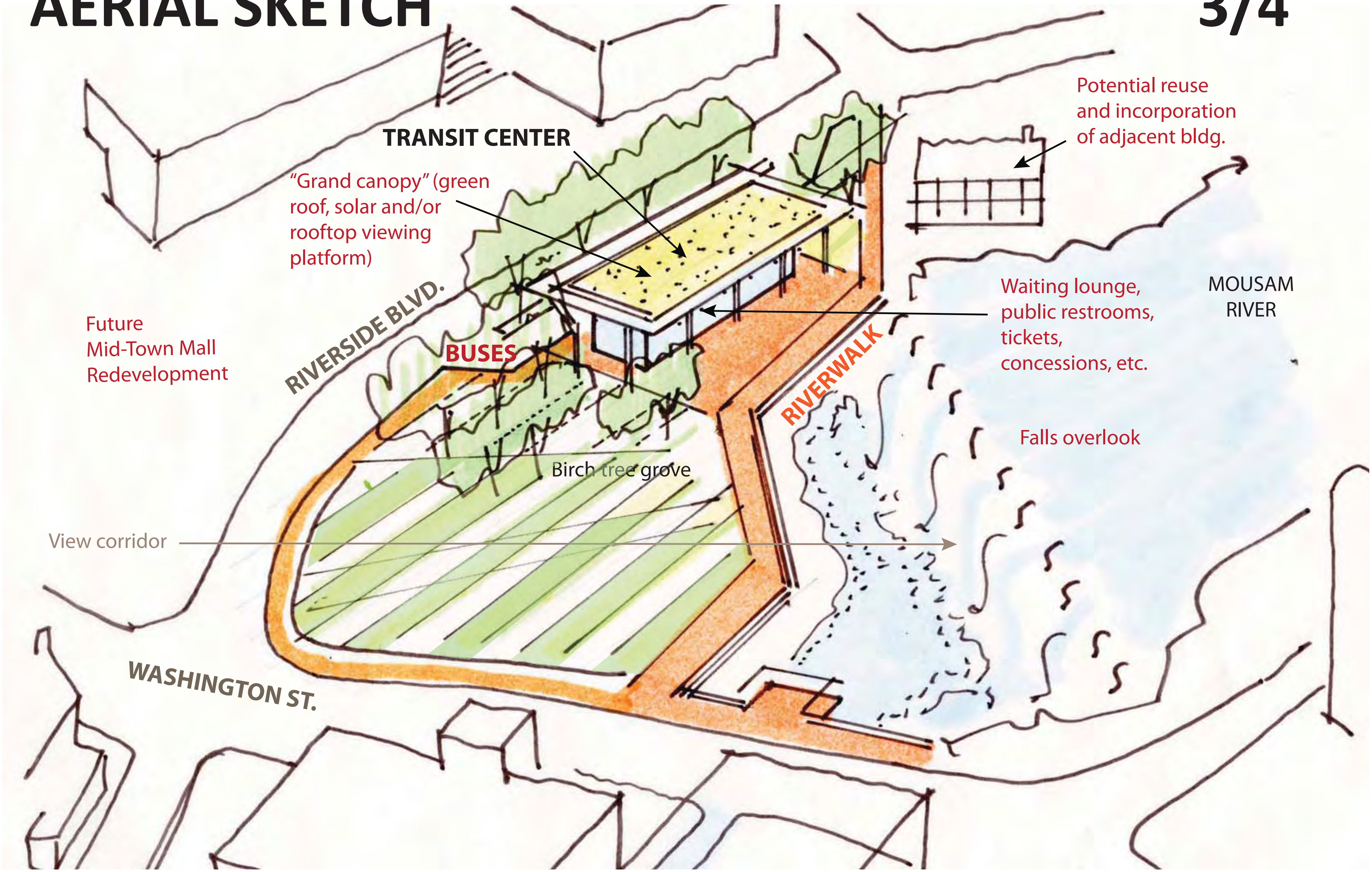
AERIAL SKETCH



SANFORD TRANSIT CENTER: **CONCEPT PLANS**

TOWN OF SANFORD BROWNFIELDS AREA-WIDE PLAN

January 19, 2012

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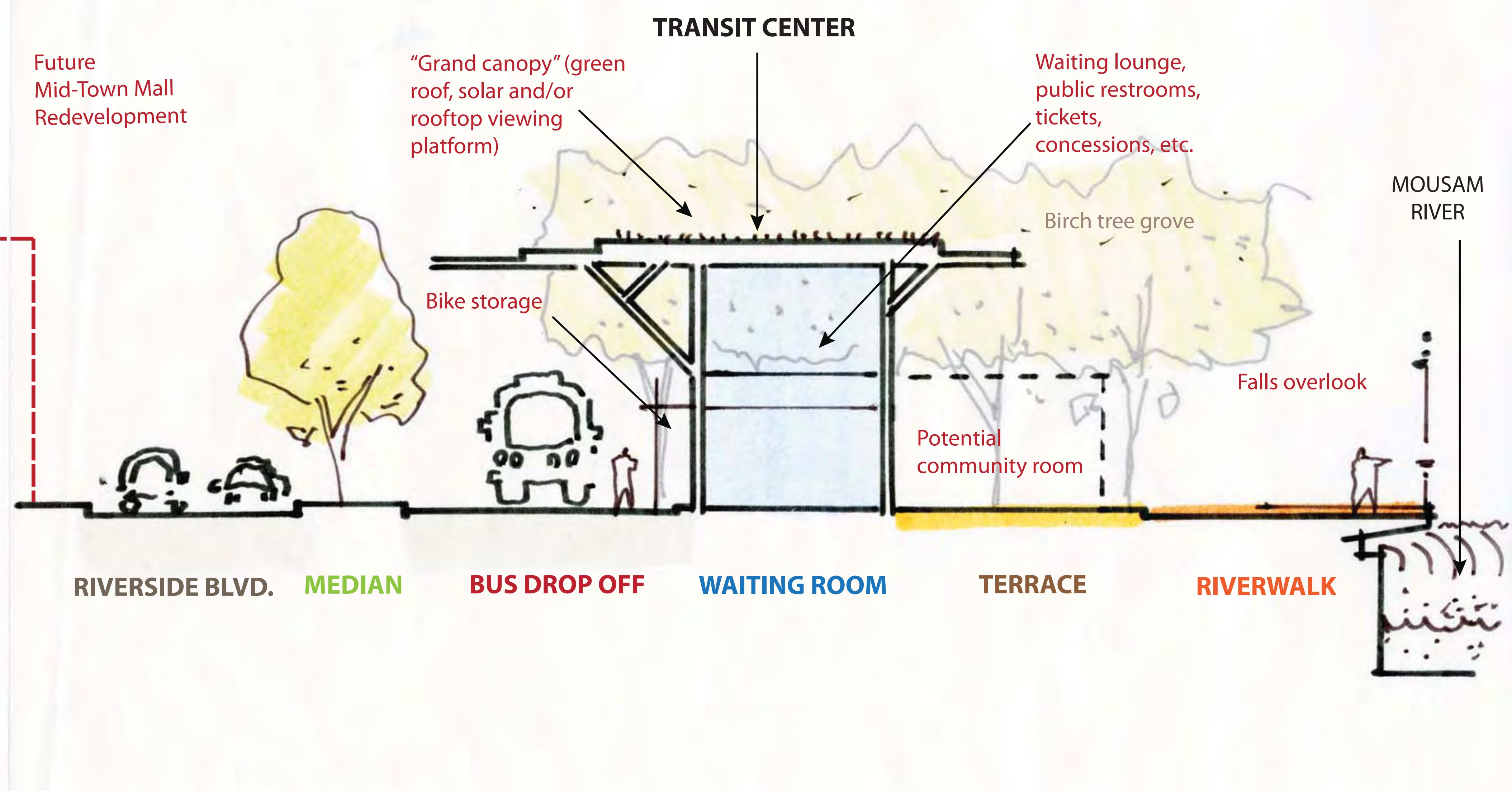
SECTION



SANFORD TRANSIT CENTER: **CONCEPT PLANS**

TOWN OF SANFORD BROWNFIELDS AREA-WIDE PLAN

January 19, 2012

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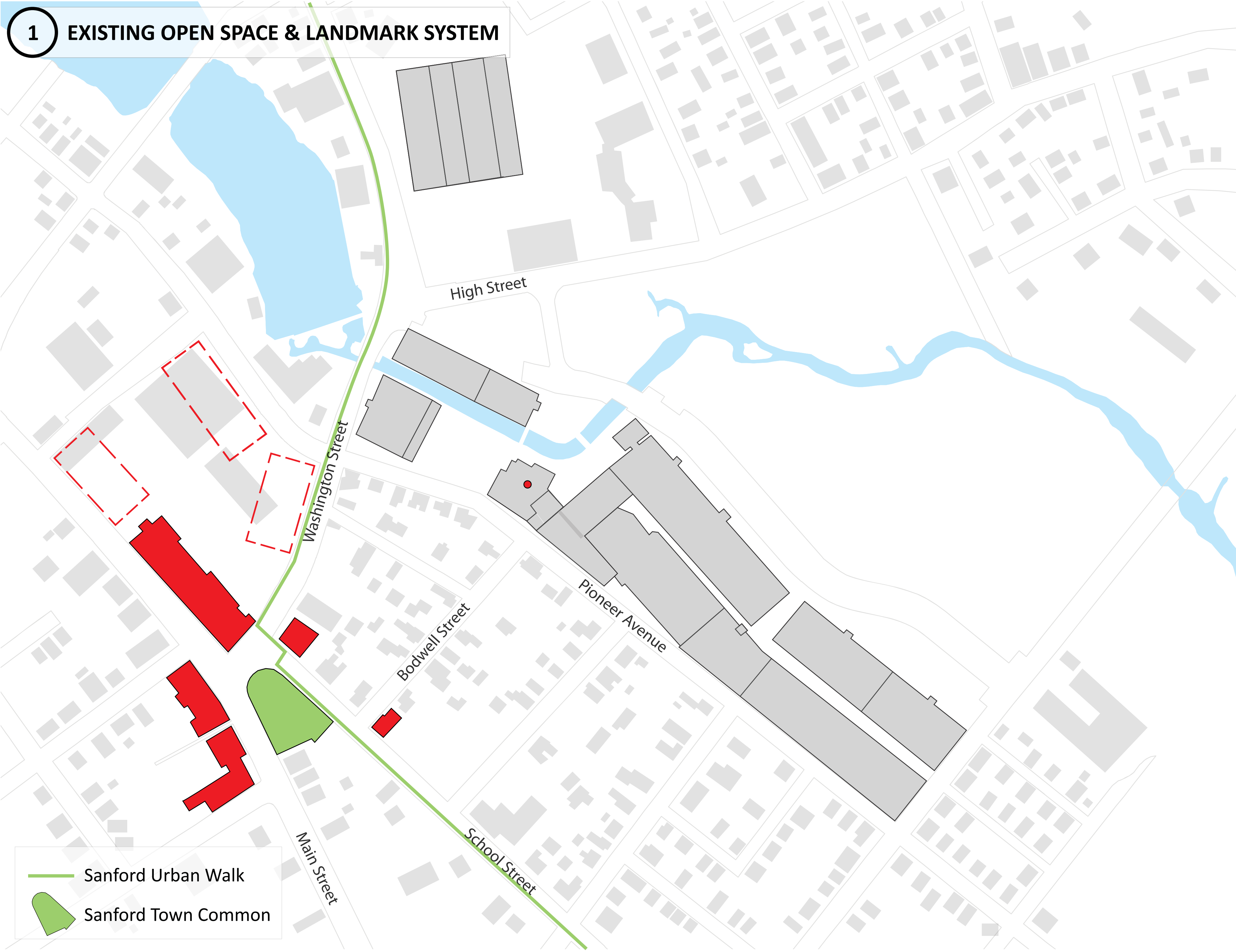
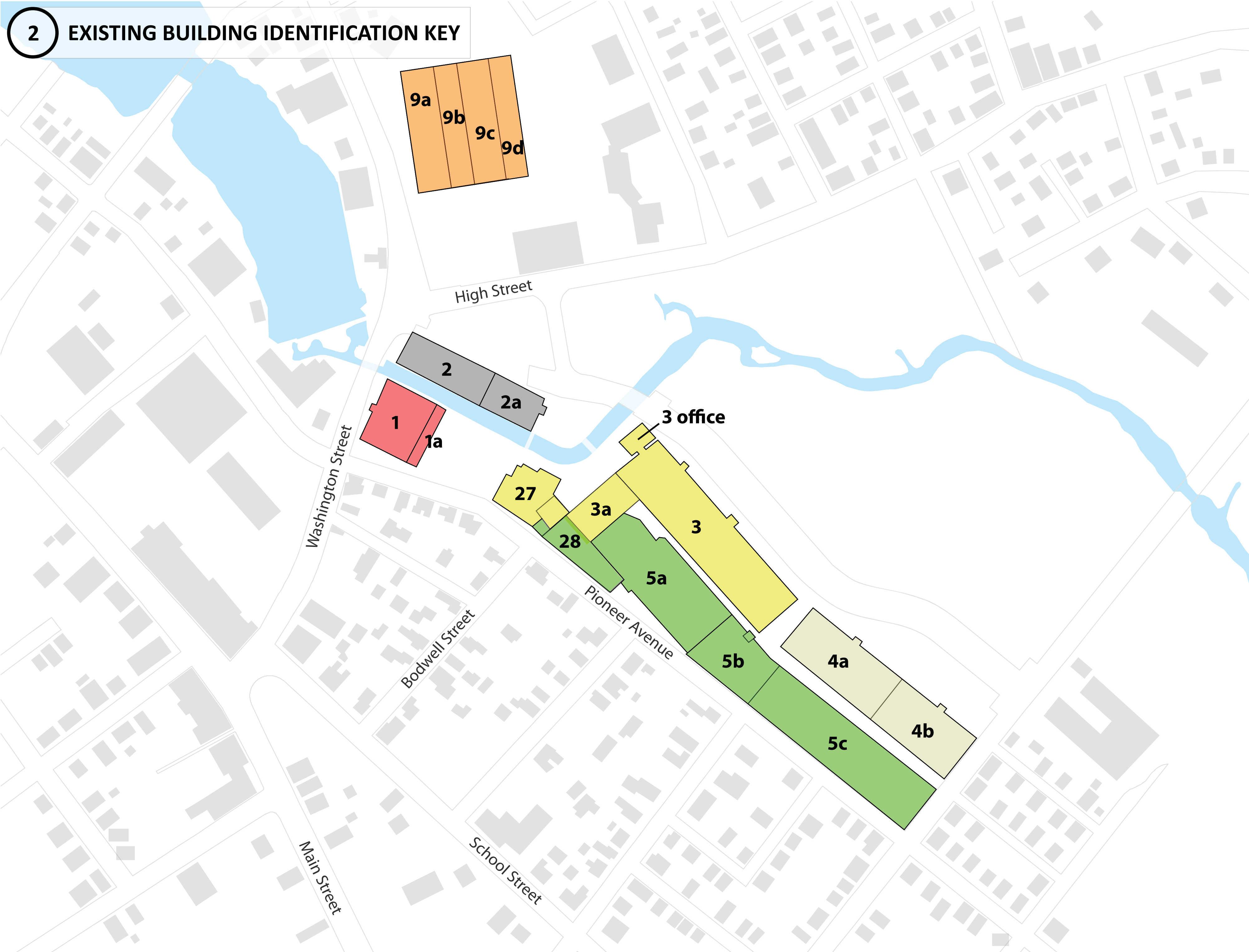
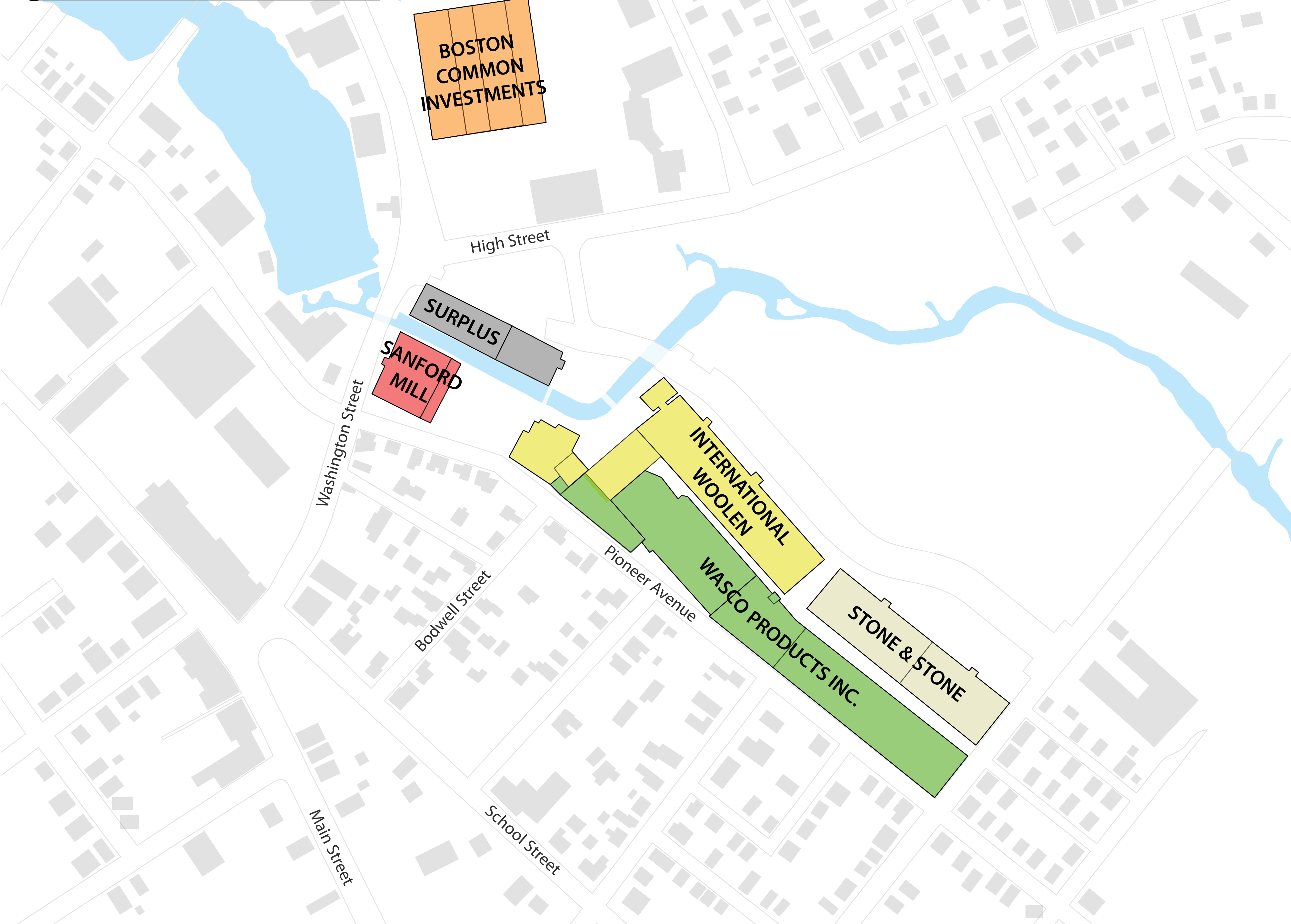
1 EXISTING OPEN SPACE & LANDMARK SYSTEM

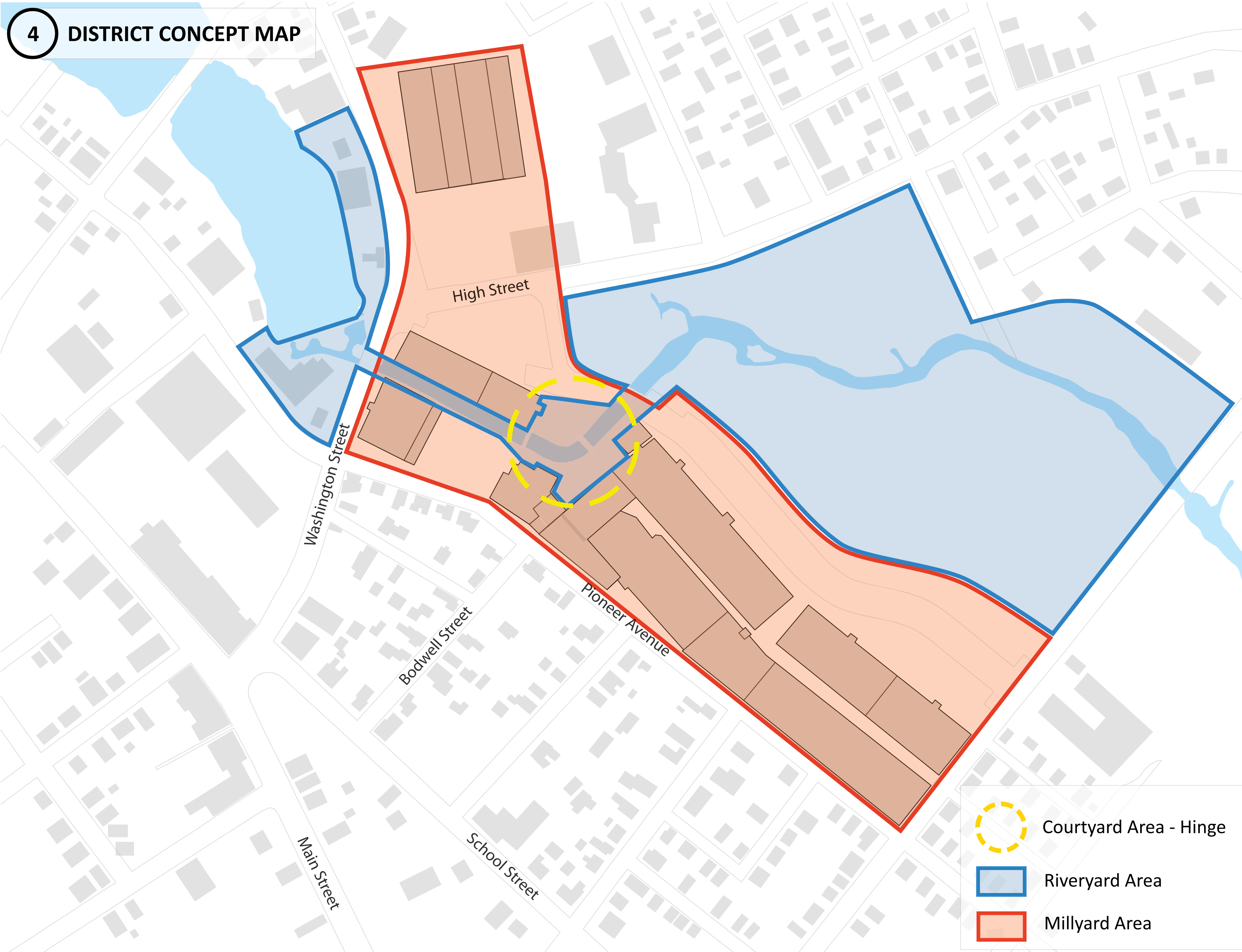


2 EXISTING BUILDING IDENTIFICATION KEY



3 EXISTING PROPERTY OWNERS

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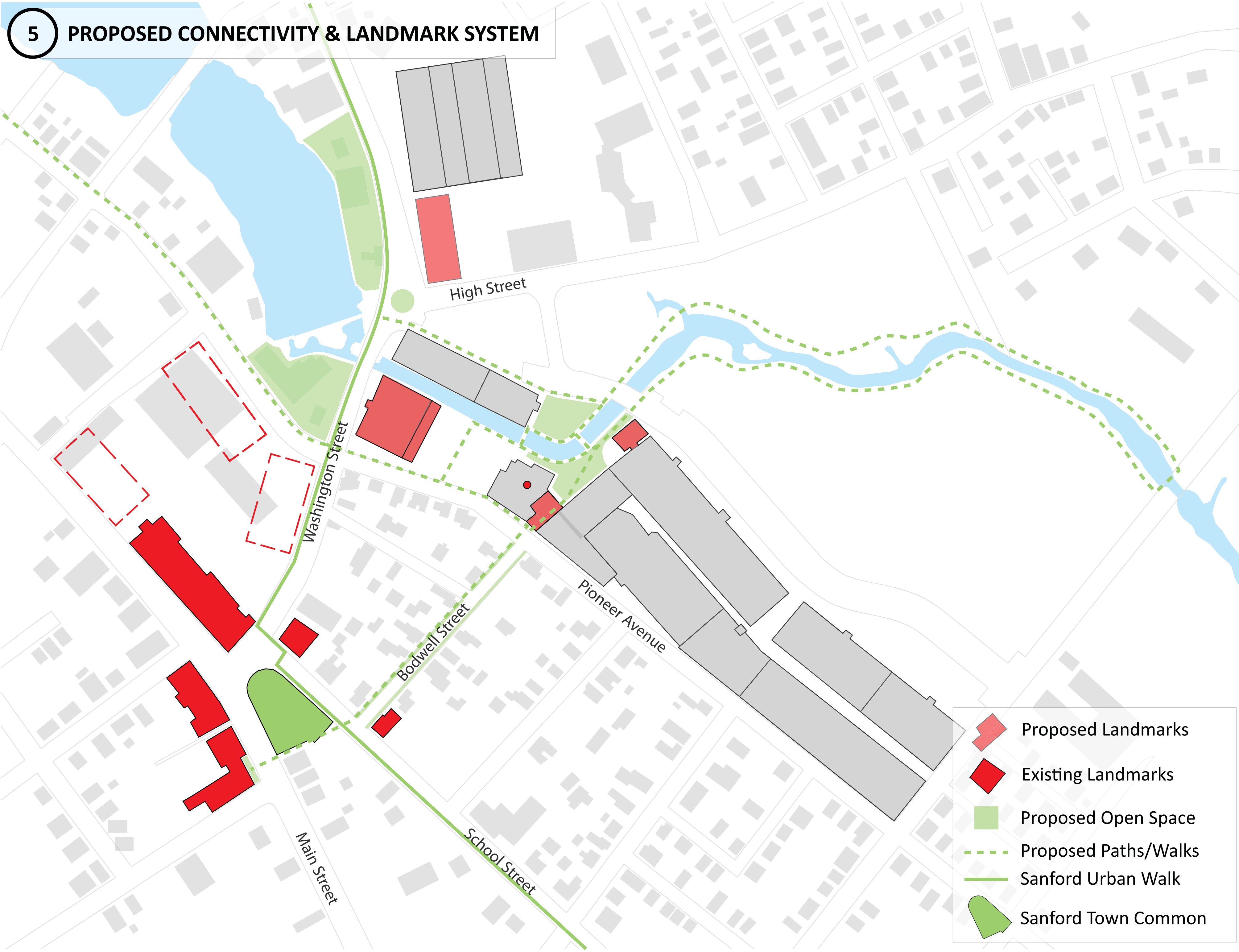
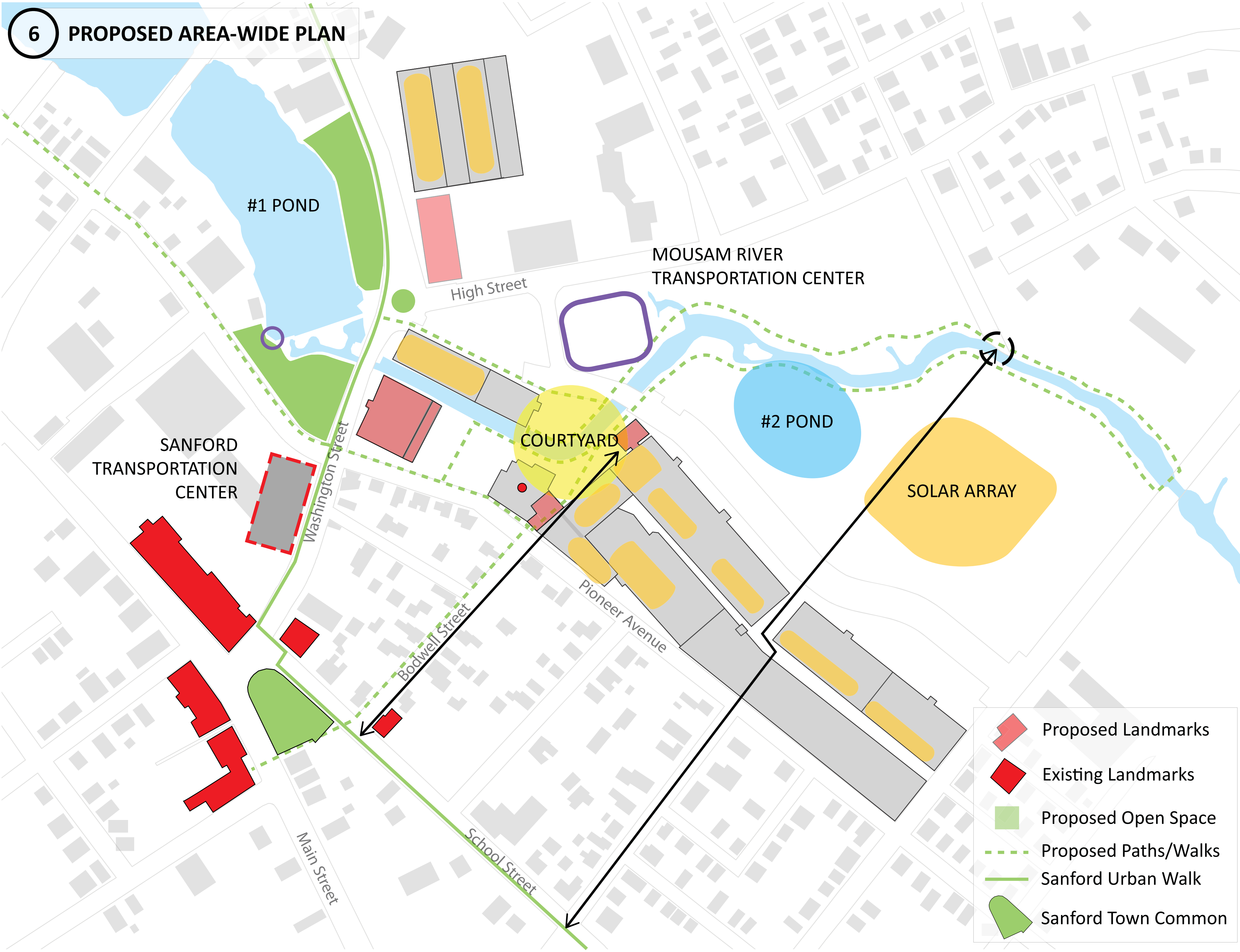
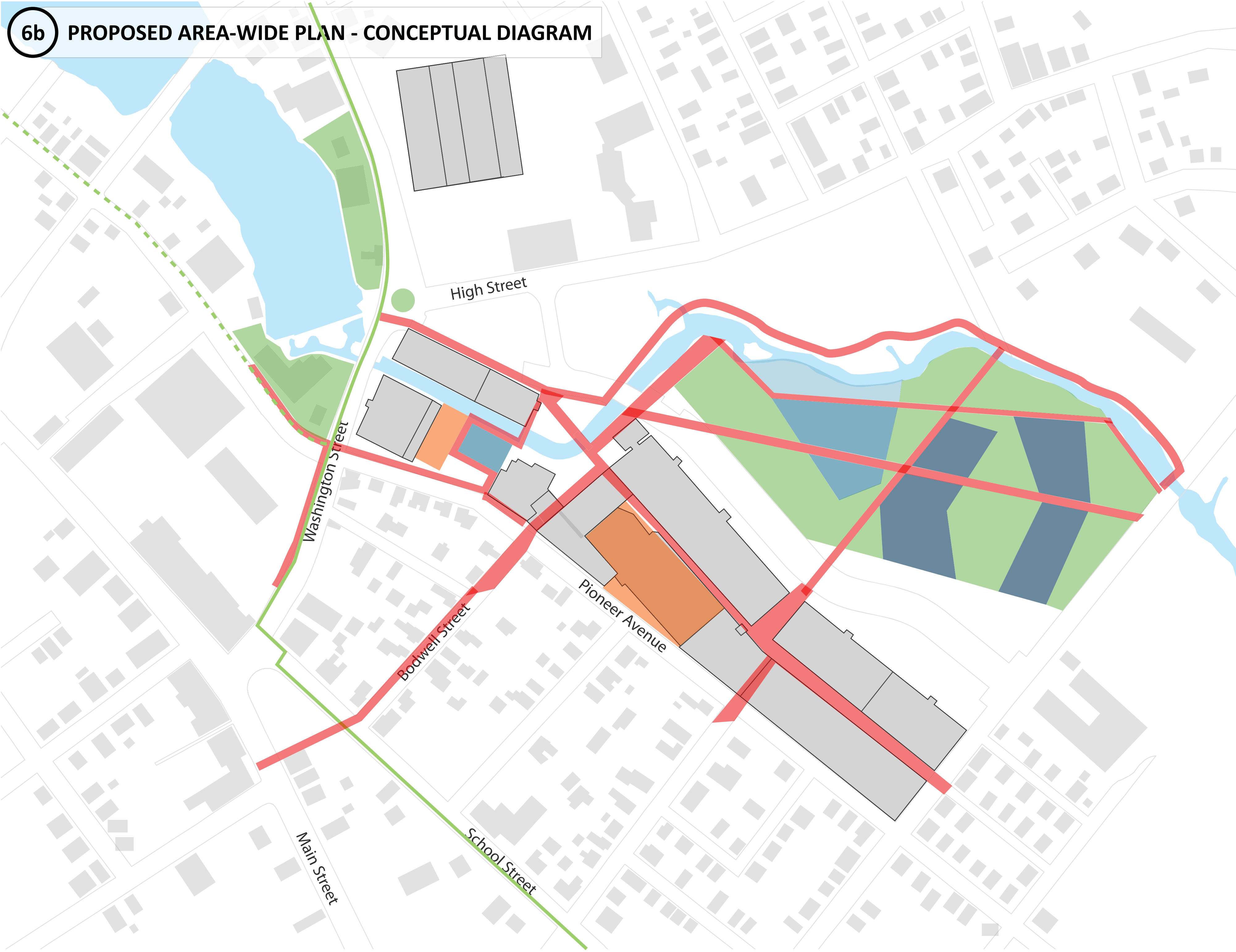
DISTRICT CONCEPT MAP
High Street
Washington Street
Bodwell Street
Pioneer Avenue
School Street
Main Street
Courtyard Area - Hinge
Riveryard Area
Millyard Area

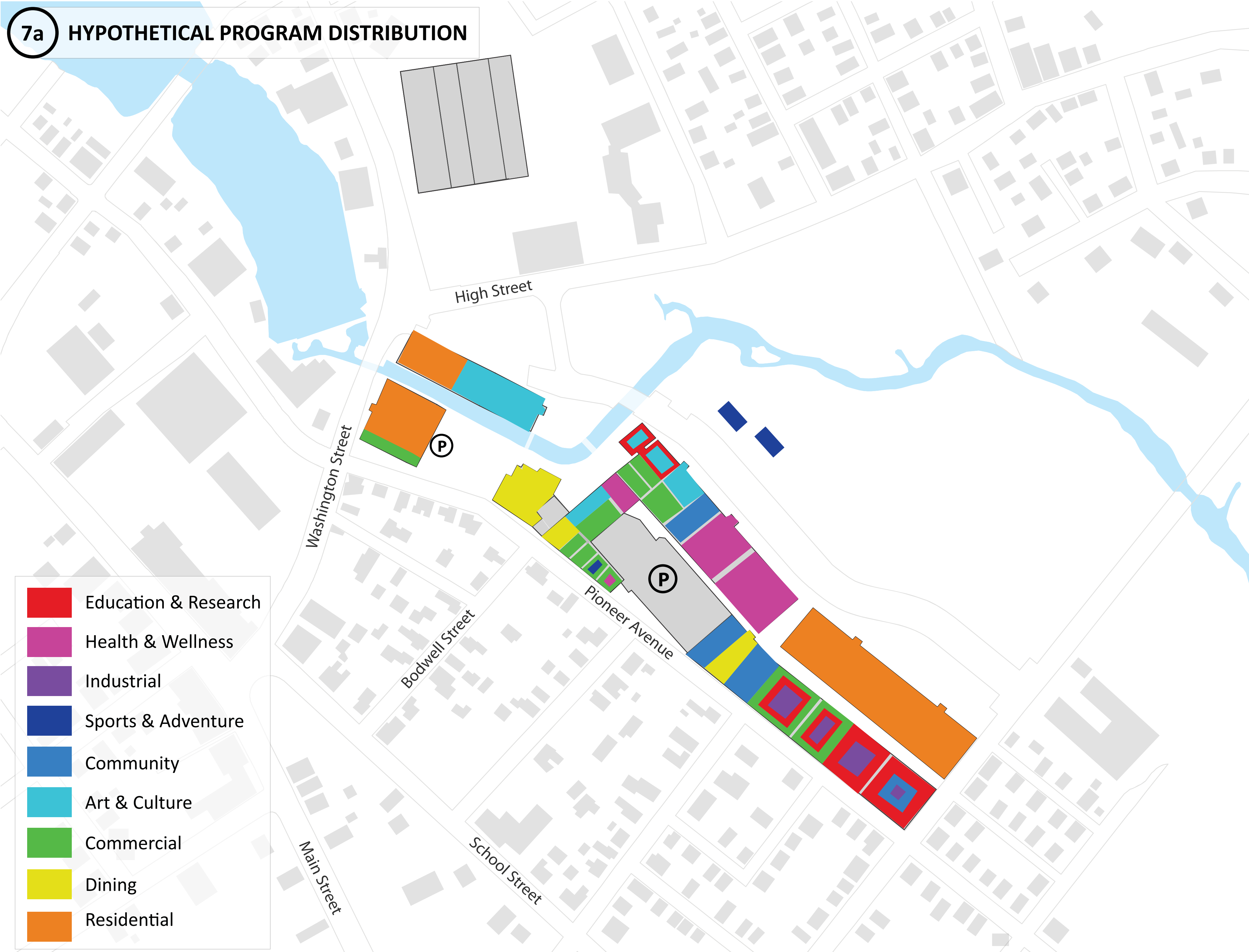

5
PROPOSED CONNECTIVITY & LANDMARK SYSTEM
High Street
Washington Street
Bodwell Street
Pioneer Avenue
Main Street
School Street
Proposed Landmarks
Existing Landmarks
Proposed Open Space
Proposed Paths/Walks
Sanford Urban Walk
Sanford Town Common



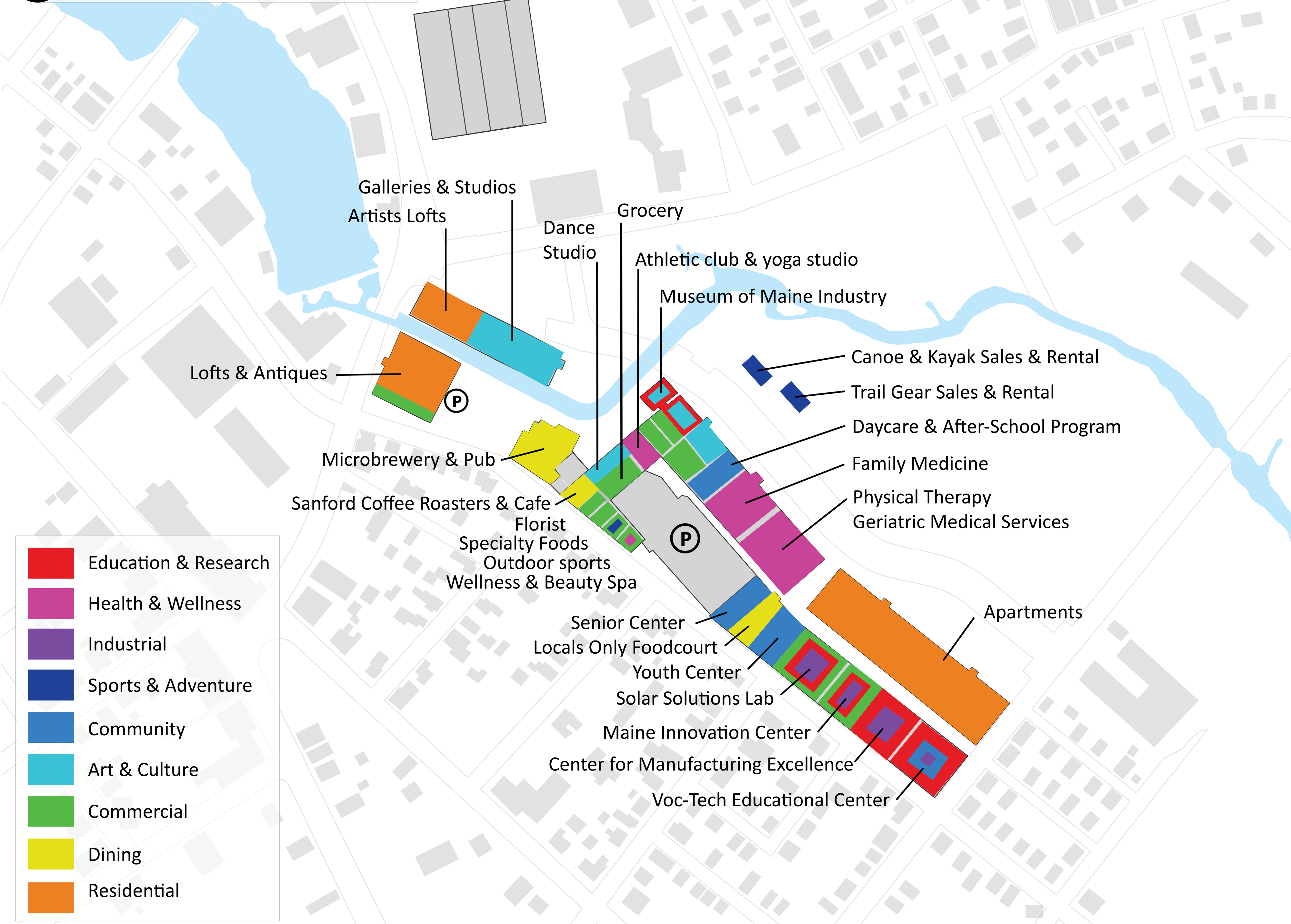
6
PROPOSED AREA-WIDE PLAN
#1 POND
High Street
MOUSAM RIVER
TRANSPORTATION CENTER
COURTYARD
#2 POND
SOLAR ARRAY
SANFORD
TRANSPORTATION
CENTER
Washington Street
Bodwell Street
Pioneer Avenue
School Street
Main Street
Proposed Landmarks
Existing Landmarks
Proposed Open Space
Proposed Paths/Walks
Sanford Urban Walk
Sanford Town Common

6b PROPOSED AREA-WIDE PLAN - CONCEPTUAL DIAGRAM



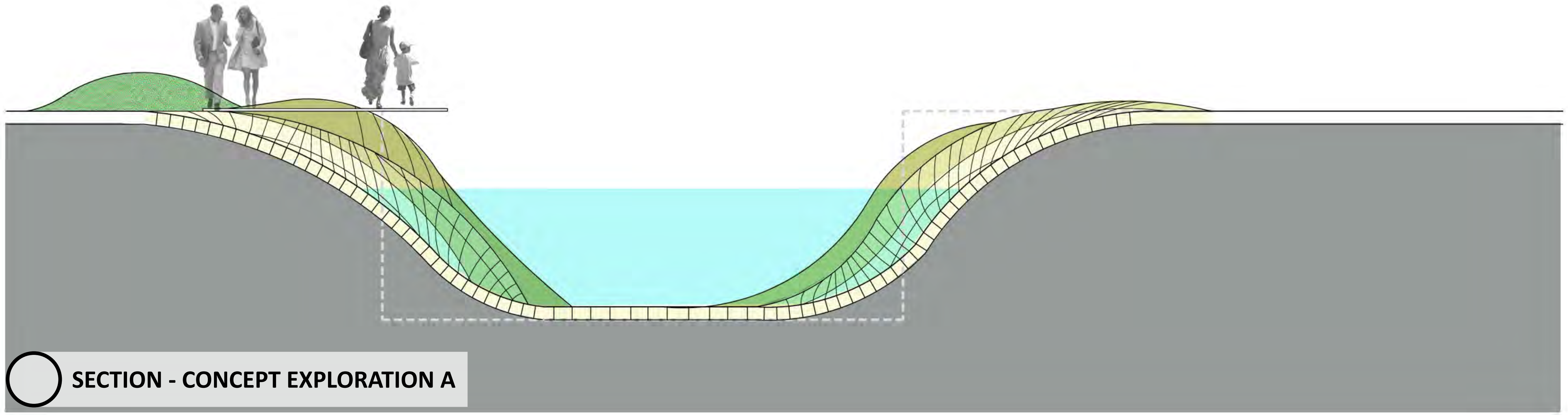

7a
HYPOTHETICAL PROGRAM DISTRIBUTION
High Street
Washington Street
Bodwell Street
Pioneer Avenue
Main Street
School Street
P
P
Education & Research
Health & Wellness
Industrial
Sports & Adventure
Community
Art & Culture
Commercial
Dining
Residential

7b HYPOTHETICAL TENANTS/USERS

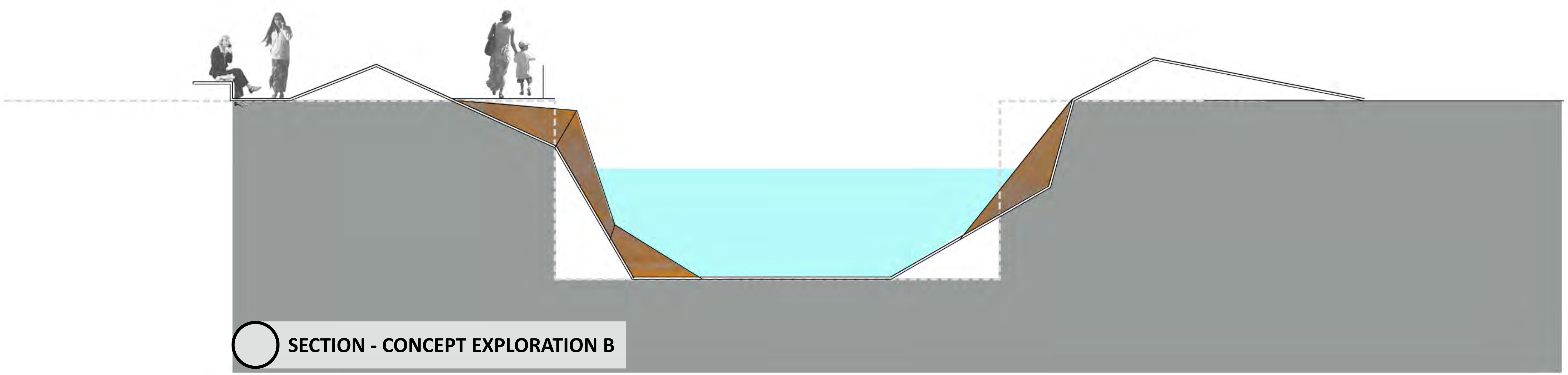


OVERLAY OF HISTORICAL WATER SYSTEMS

CONCEPT EXPLORATION SECTIONS

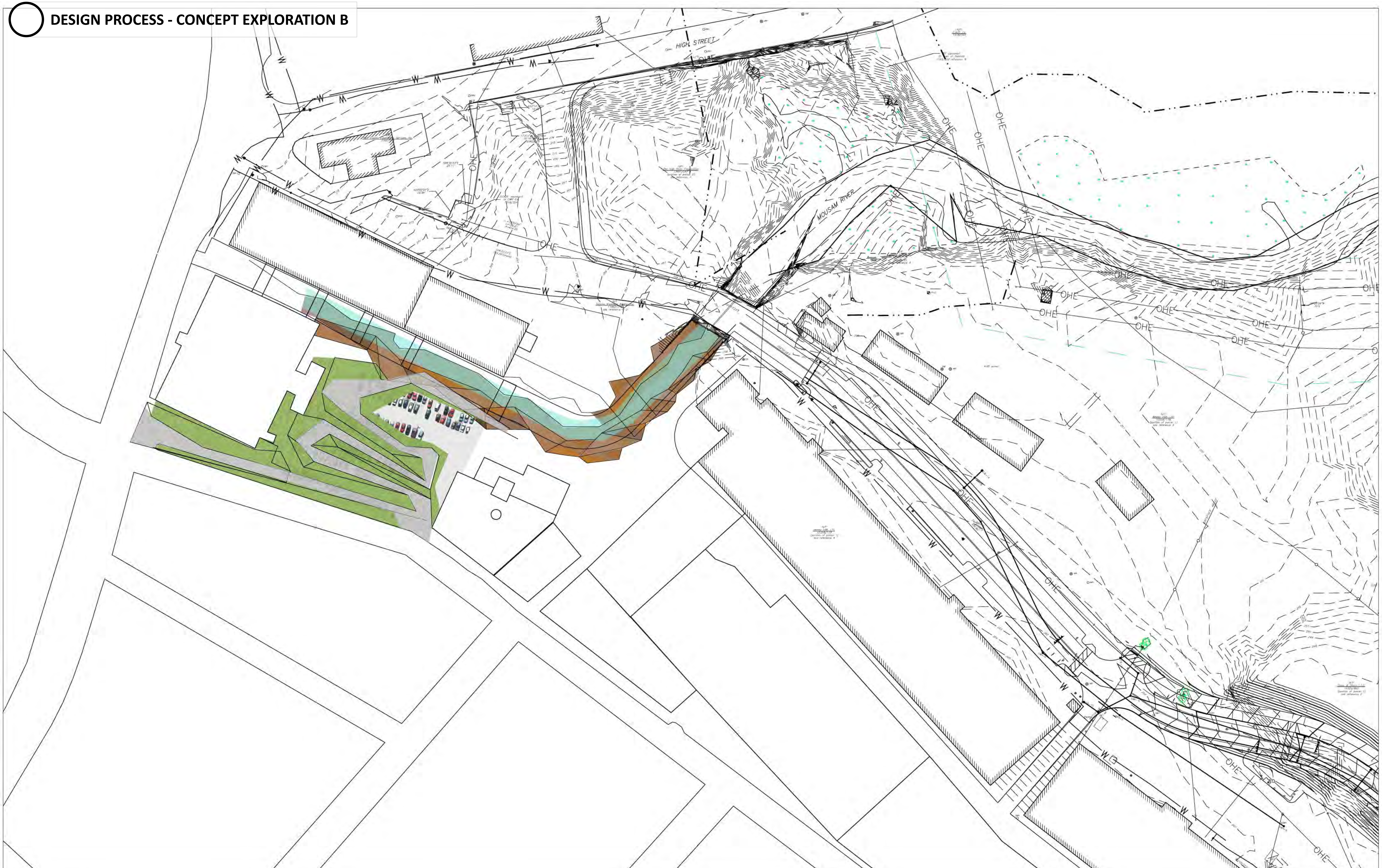


SECTION - CONCEPT EXPLORATION A

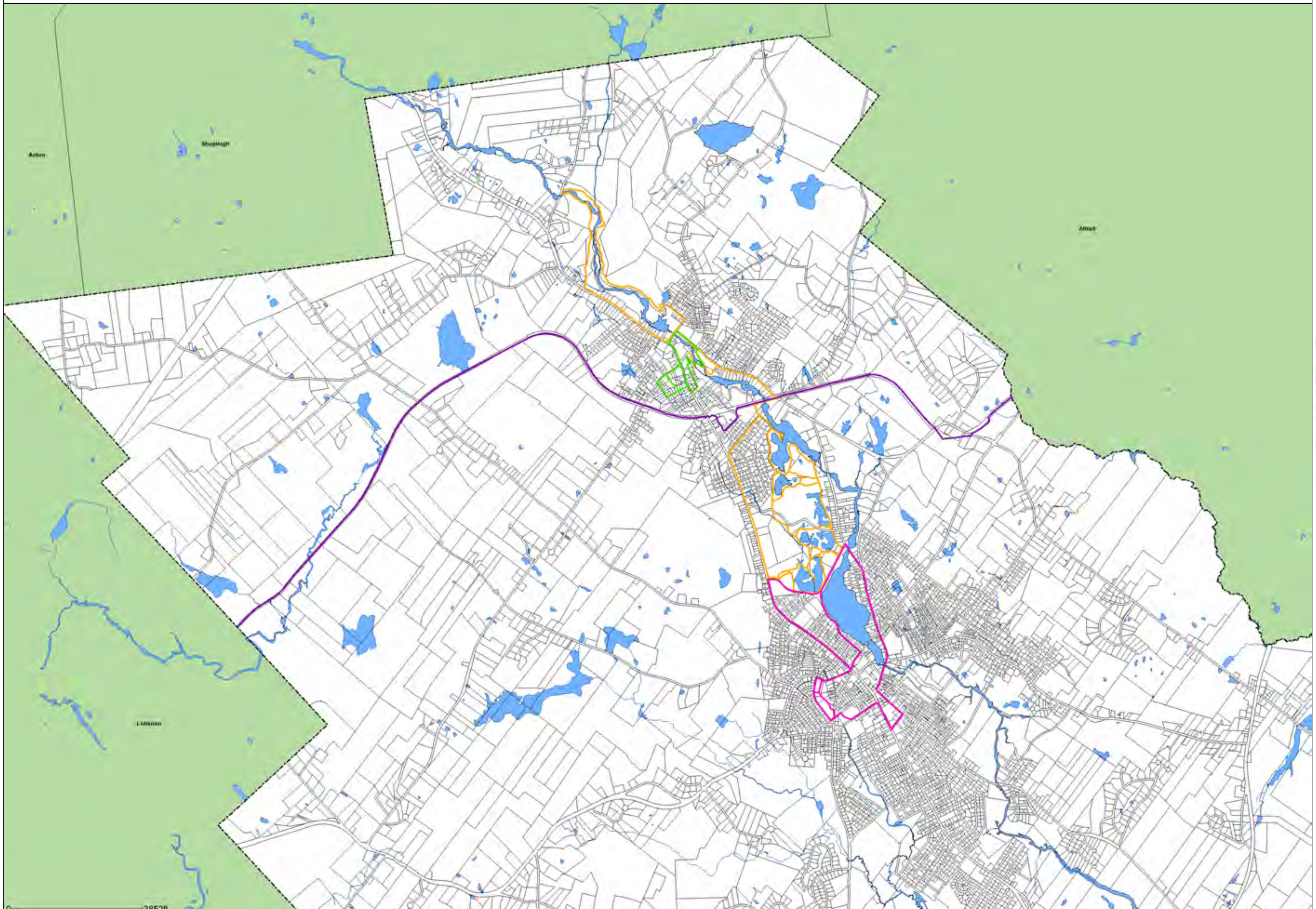


SECTION - CONCEPT EXPLORATION B

DESIGN PROCESS - CONCEPT EXPLORATION B



Sanford Area Map with Trails

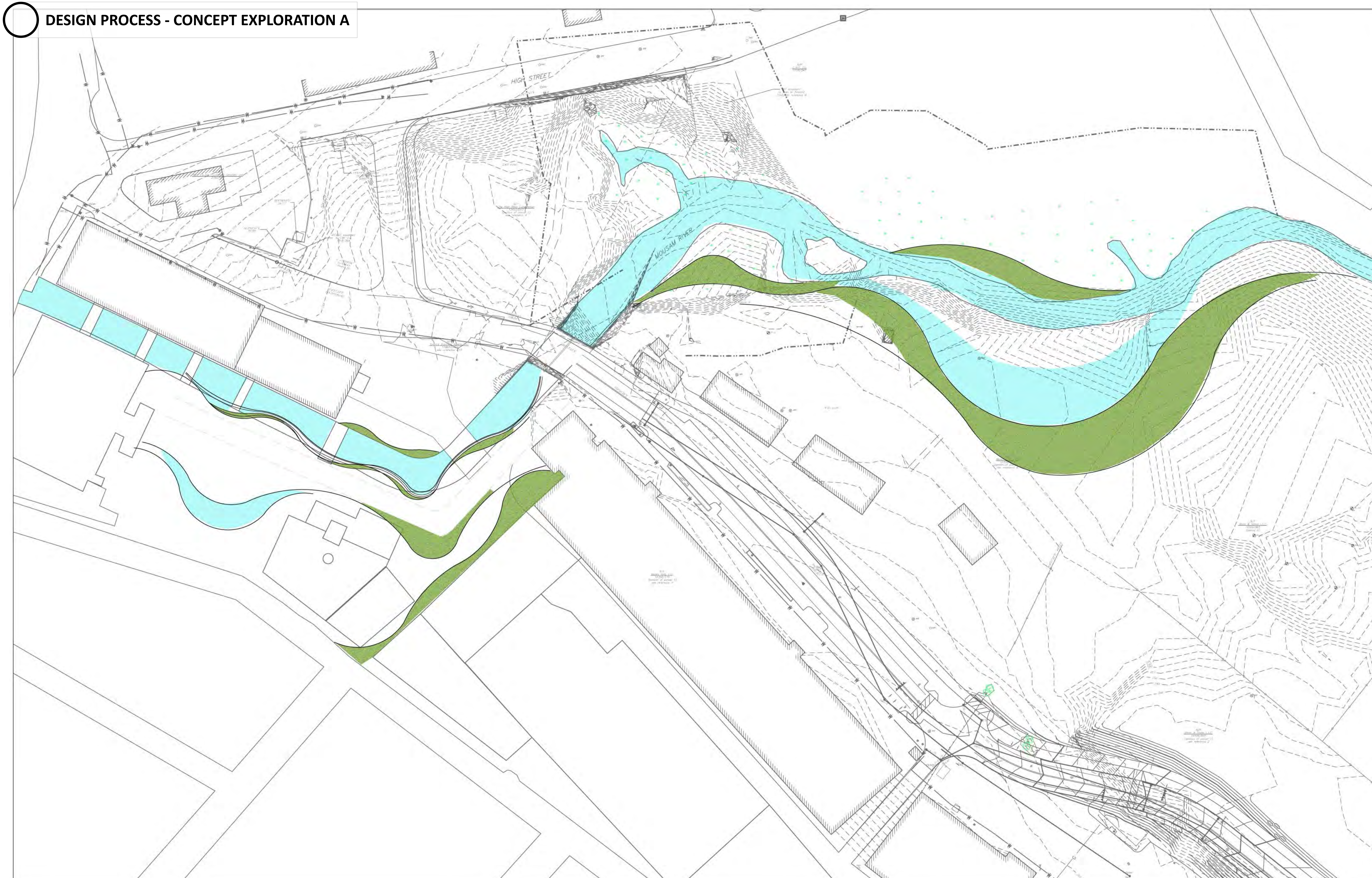


Town Boundary
Trails
Rail Trail
Urban Walk, Sanford
Urban Walk, Springvale
Selected Parcels
Hydrography
Waterbodies
Surrounding Towns
Water
Sanford

Disclaimer
The information shown in this website is provided as a service to the citizens of the Town of Sanford and other interested persons, and has been compiled from various public and private sources. While every effort has been made to provide accurate information, the Town cannot and does not warrant the accuracy of property and boundary lines, the dimensions of lots, the location of structures or improvements, or topographic or geologic features on the land. Only on site verification or field surveys can provide such accuracy. Parcel delineation is current as of April 1, 2010. Questions about this site can be directed to the GIS Manager.

November 04, 2011

DESIGN PROCESS - CONCEPT EXPLORATION A

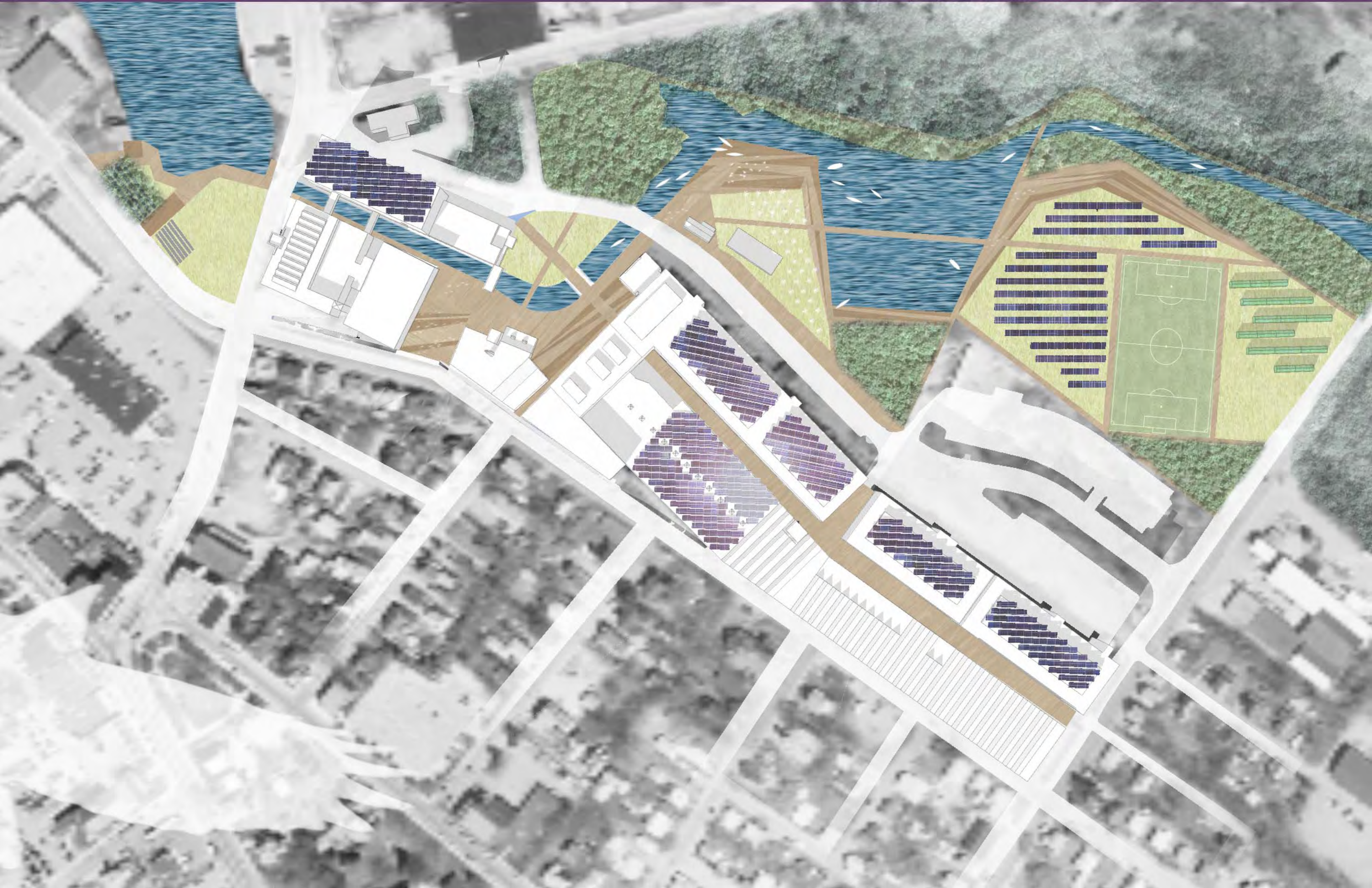


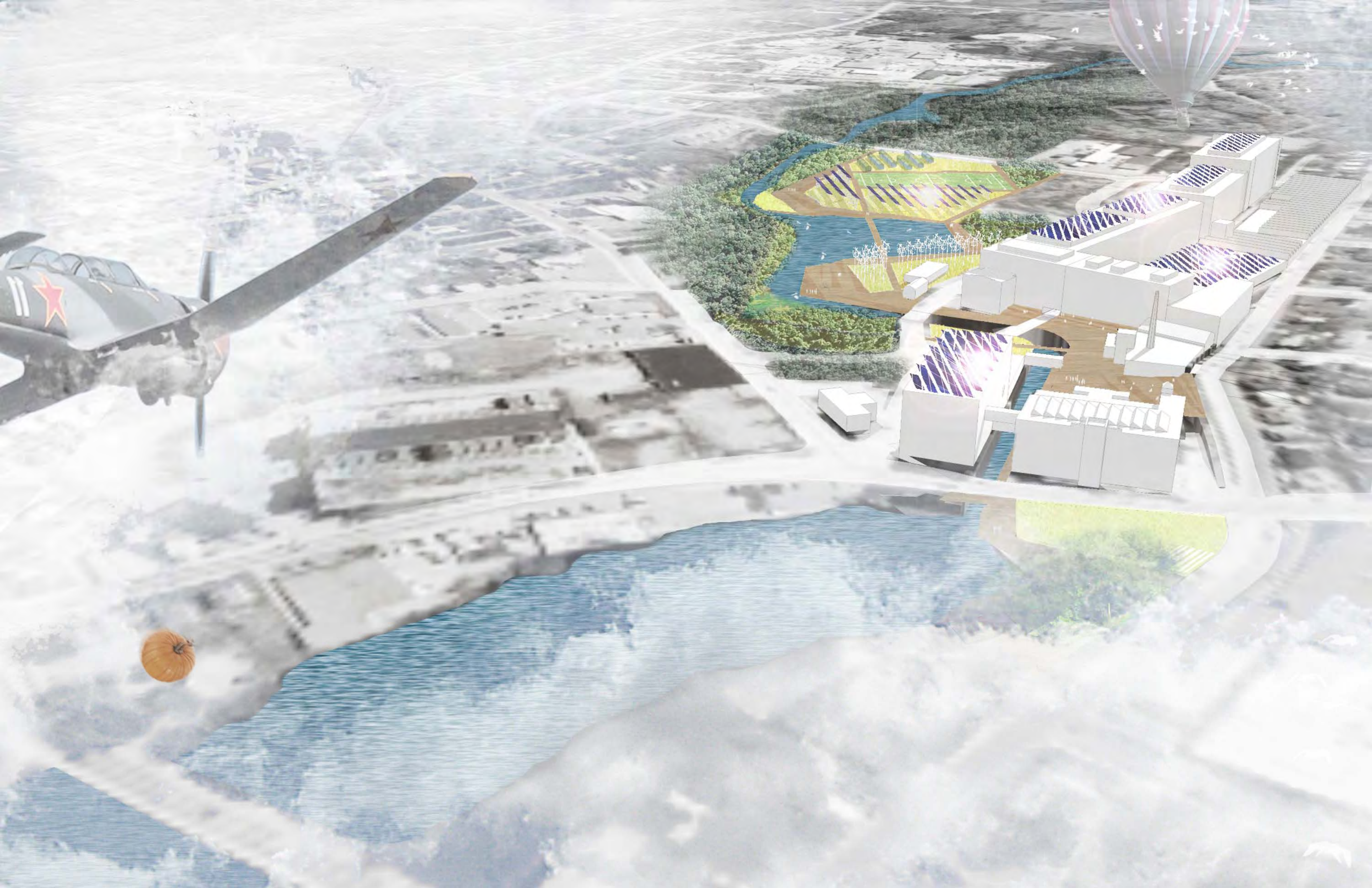
Open Space Strategy

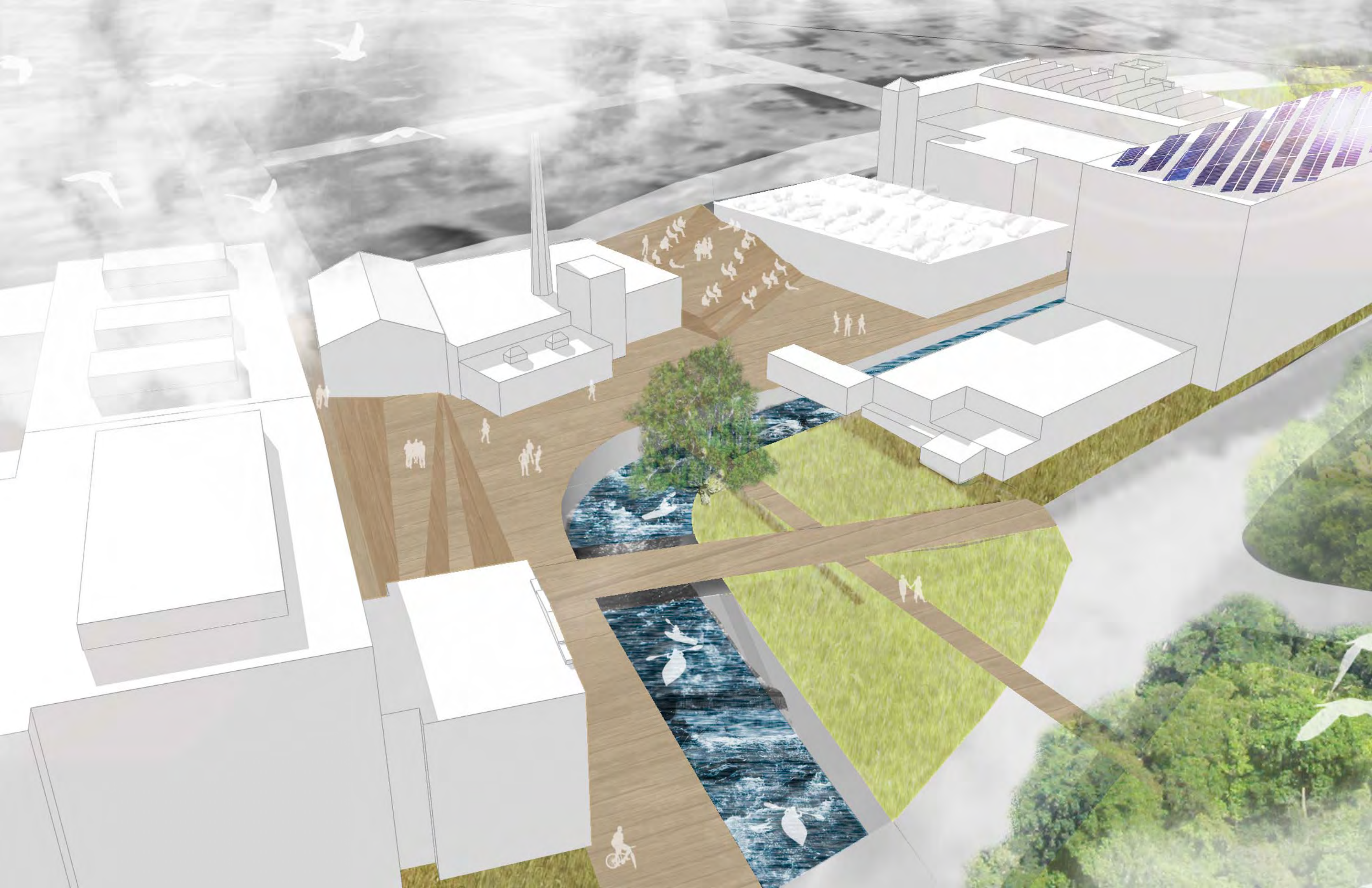
The Town of Sanford has a strong outdoor trail network and a culture of water recreation. A new River walk along the Mousam River will build upon this system of outdoor activity and connects the town's residents to the river around which the town was built. The incremental reuse of the Millyard complex, and the creation of a new sustainable landscape centered around an engineered "Number Two Pond", connect the redevelopment of the Mills with the remediation of the land.

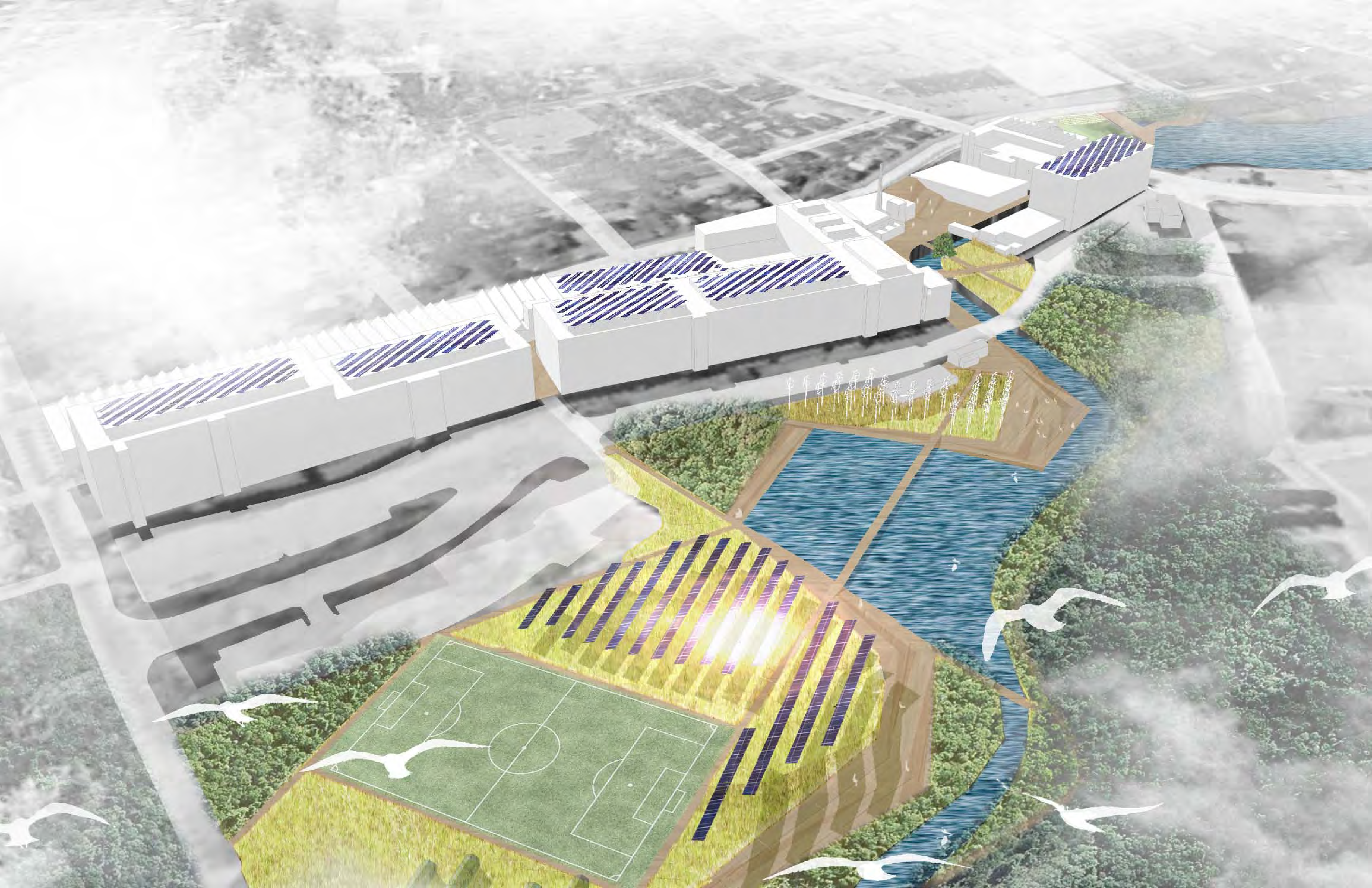
THE LANDSCAPE

The Millyard is well positioned to advance the visibility of health and wellness in the region through the remediation of Brownfield Sites associated with the historic Mill Operations, and the positioning of the town and the region as a hub for alternative energy technologies. Nestled within this remediation and energy production landscape will be a series of active and passive public spaces, including soccer fields, community gardens, open spaces, boardwalks, and a re-imagined "number two pond", created on the site of an historic pond along the Mousam. These public spaces will connect a number of regional trail networks and attract tenants interested in living near such amenities for health and wellness. The design of the trail network will promote physical activity and increase community awareness of the benefits of active living. The Riverwalk and Number Two Pond will increase opportunities for physical activity by extending the existing trail system which **enhances linkages with adjacent neighborhoods**. A more robust open space network can also influence the policies and partnerships that support active living in Sanford and York County. Providing spaces for public gathering and community interaction will help weave a stronger community into this historic mill town.









APPENDIX

MILLYARD HANDBOOK (insert)

Sanford Area Map of Trails

TOWN OF
SANFORD

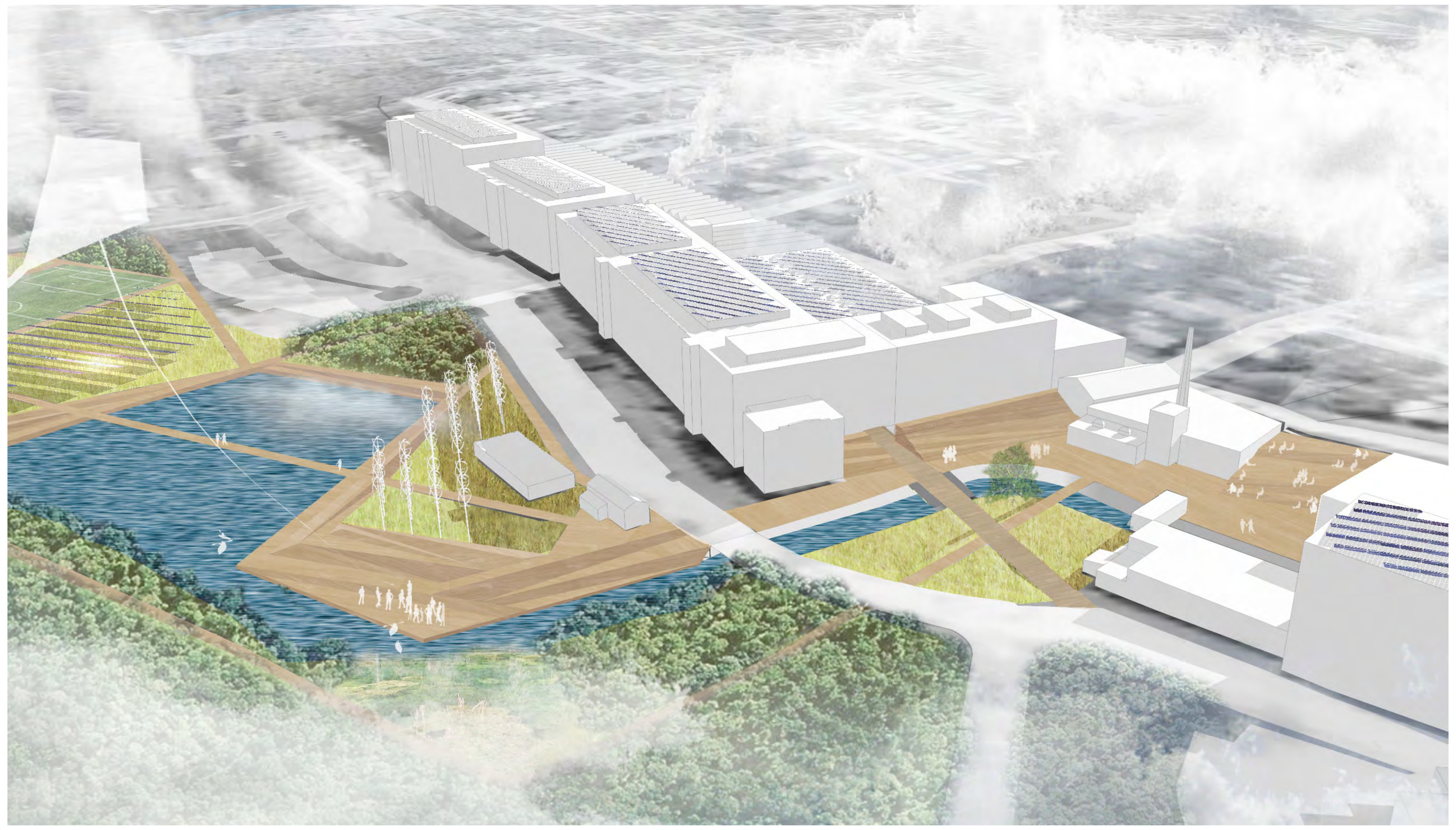
A
POCKET GUIDE
to understanding the Assessment Repositioning and Rehabilitation of the **Millyard**

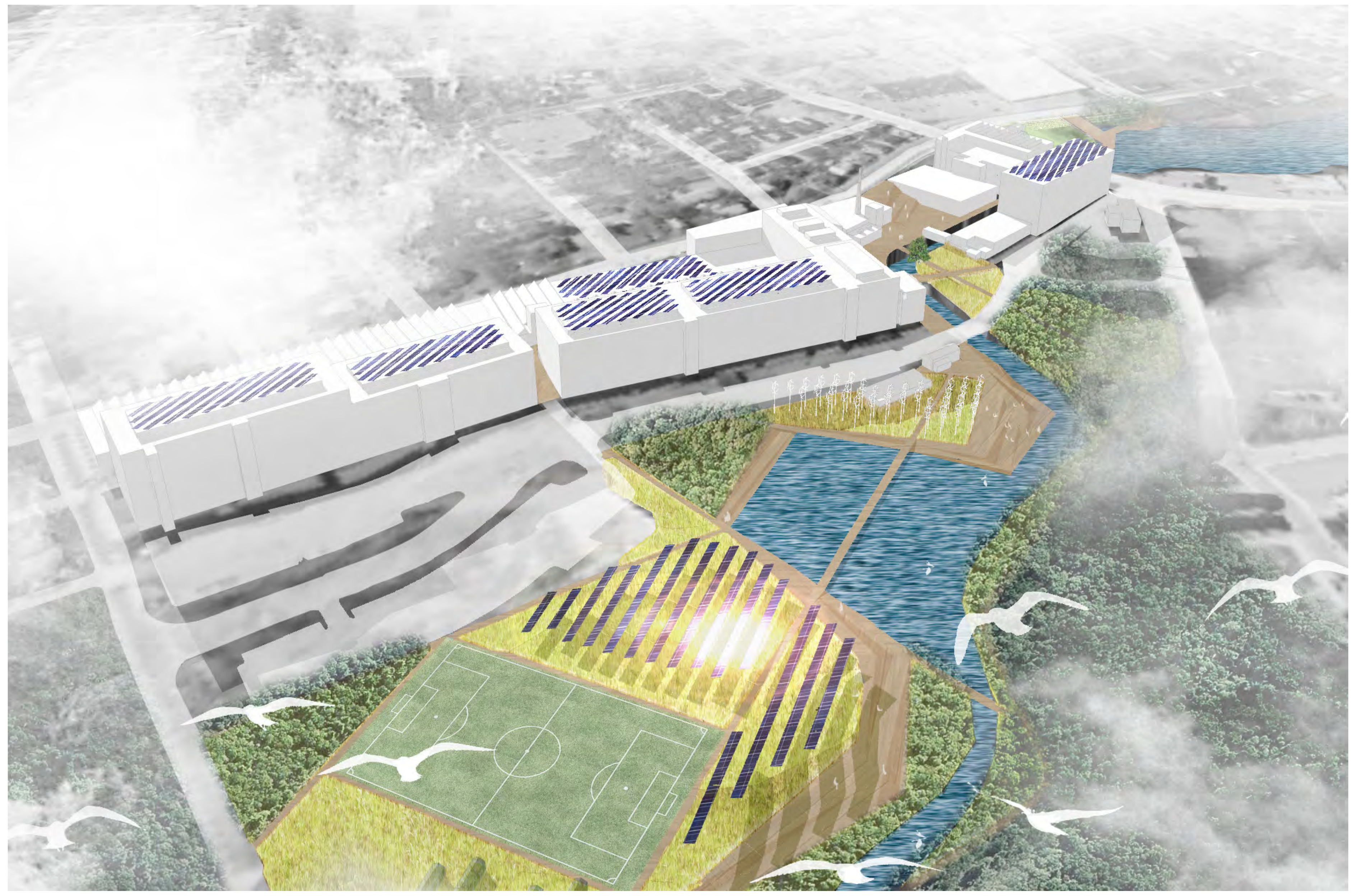
BROWNFIELDS AREA-WIDE PLANNING

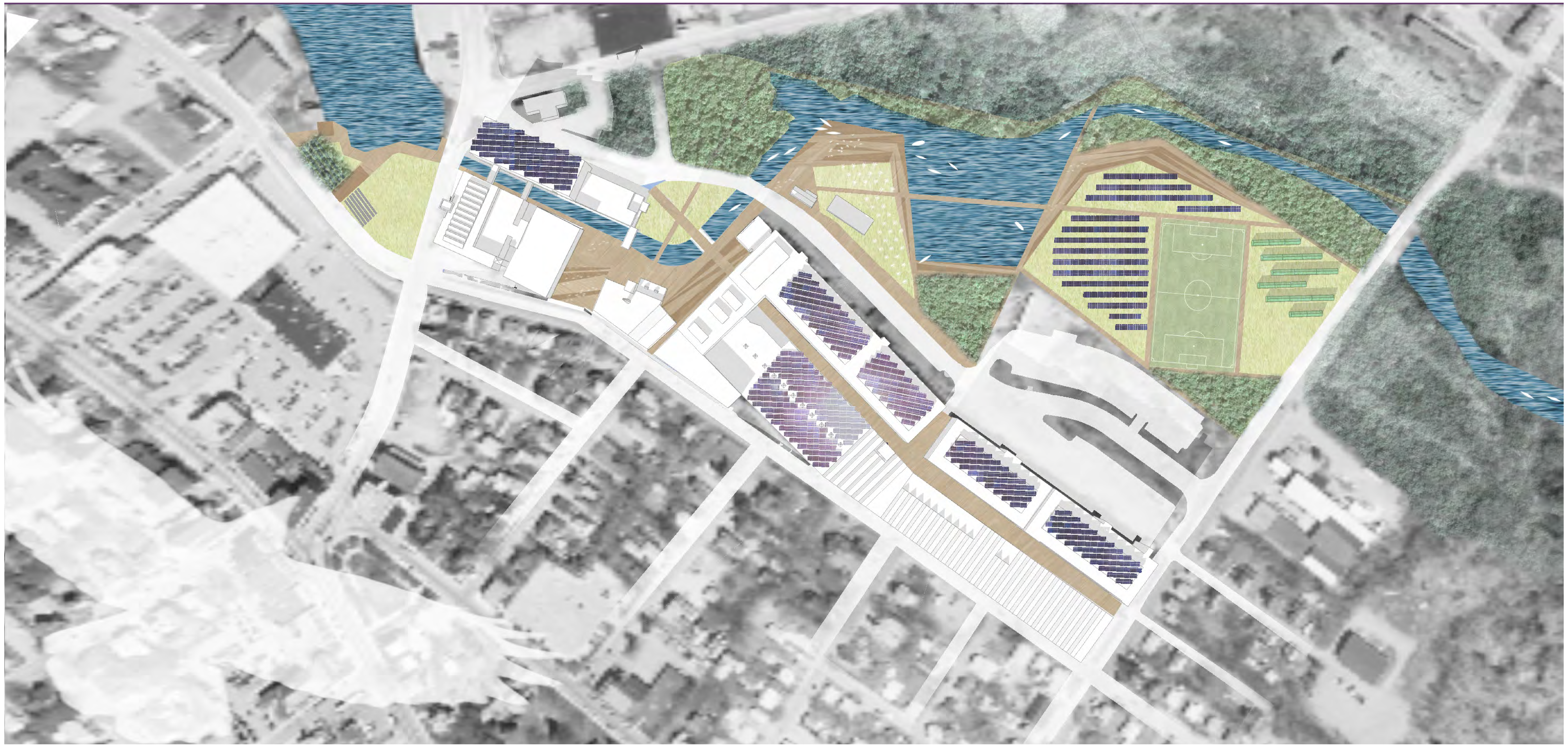
REVITALIZATION STRATEGY
Sanford must build upon its existing assets in the development of a "brand" that is focused on **specific market niches.** These niches need to benefit from the assets of the Town that are not currently identified with any other community in Maine.

Those niches are:
SUSTAINABILITY
HEALTH & WELLNESS
RECREATION

PILOT
PROGRAM







THE SANFORD MAINE MILLYARD

RE:VISION

THE FUTURE
The ability to craft and implement a successful redevelopment program for the Sanford Mill District depends as much on the desirability of the Town of Sanford as a business location as it does on the economics of the properties themselves. The most strategic approach is to build on Sanford's existing assets in the development of a new "brand." The brand must be focused on a specific market niche that is most likely to benefit from the assets of the Town as a whole, and one that is not currently identified with any other community in Maine.

Sanford's market niche is to become a Center for Sustainability, Healthy Lifestyle and Outdoor Recreation. The Town already has a strong trail network and culture of water recreation. A new Riverwalk builds on this system. The incremental reuse of the Millyard complex, and the creation of a new sustainable landscape centered around "Number Two Pond", connect the redevelopment of the Mills with the remediation of the land.

Renewable energy technologies (solar, geothermal and hydropower) will attract industries that would not otherwise come to the Millyard. These technologies combine to create a national model for power generation and environmental remediation.

REUSE PROGRAMS & POTENTIAL USERS

SUSTAINABLE ANCHORS
•Textile Museum •Center for Manufacturing Excellence •Innovation Center •Technical and Art Education •Renewable Engergy Manufacturing

HEALTH& WELLNESS
•Wellness Clinic •Senior Center •Daycare •Physical Therapy and Rehabilitation Clinic •Yoga Studio •Grocery •Hydroponic Farming

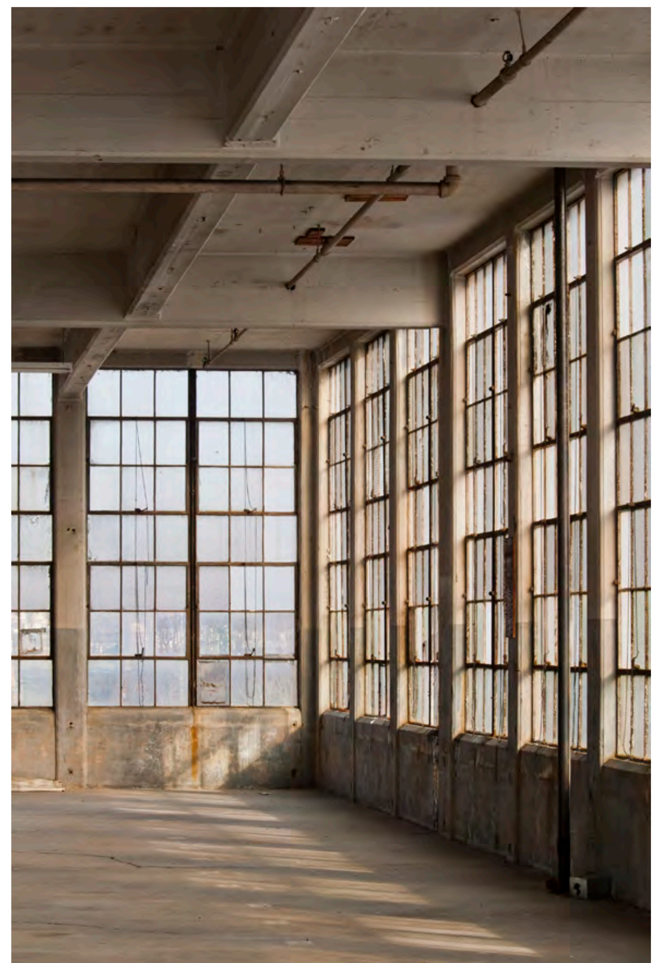
RECREATION
•Outdoor Footware Distributor •Canoe Rentals •Trail Gear •Kite Shop

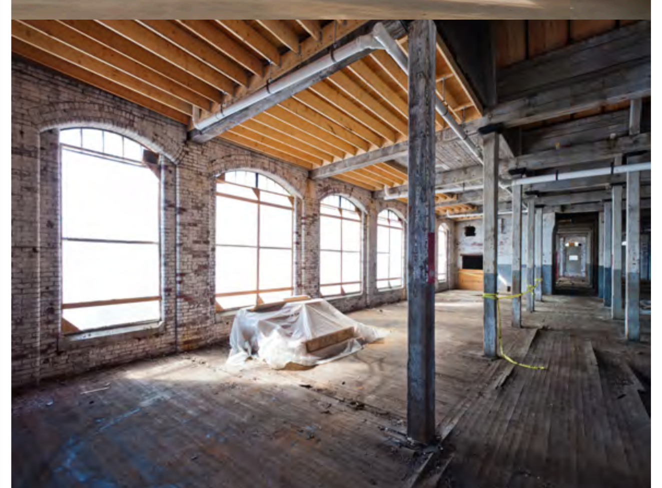
BUSINESSES NICHES
•Puppet Theater •Dance Studio • Art Gallery • Antique Shop •Organic Coffee Roasters •Ceramics •Florist •Print Shop

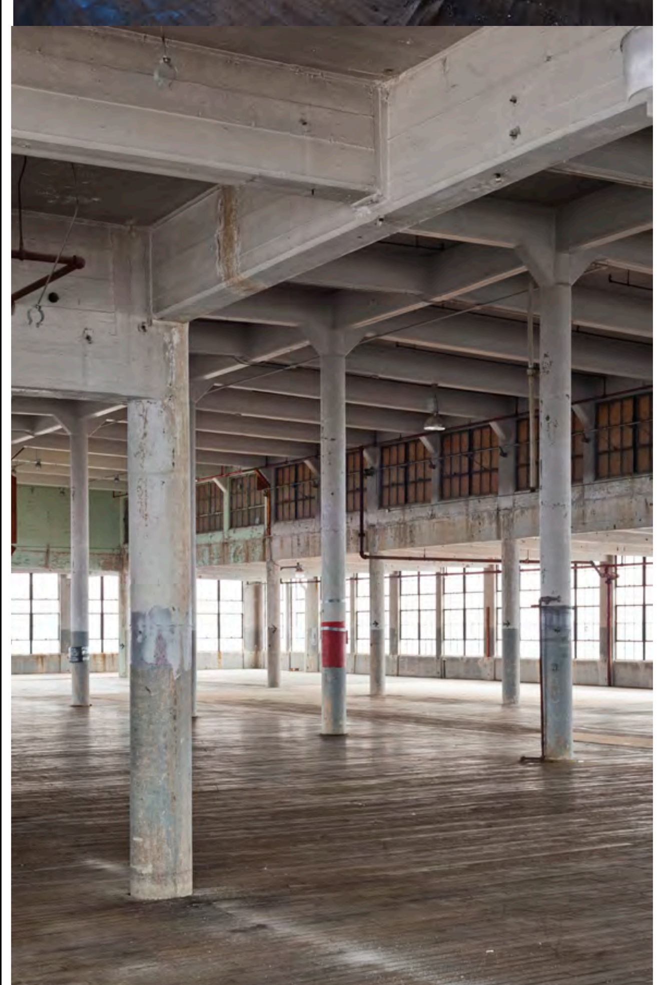
DINING & SHOPPING
•Mousam Microbrewery •Kortoffel Pub •Millyard Muffins •Riverwalk Cafe

JUNE 19 2012
SUBMITTAL

REDEVELOPMENT PLAN







Millyard photos by Christian Phillips Photography (2012).

REHABILITATED INFRASTRUCTURE

DEVELOP A GAME CHANGER
The most effective method of preventing suburban sprawl is through more **intensive use of buildings and sites already in place**. The mill buildings were built in the downtown core, in close proximity to other establishments and near transit that minimizes transportation-related energy consumption. Building on or near existing infrastructure allows local governments to avoid investment in costly, inefficient infrastructure extensions, which themselves can fuel more sprawl. It is expensive to extend services to outlying areas.

As part of the Area-wide Plan, an audit of the existing infrastructure was made. The audit revealed the following conditions about the site's existing utilities.

NATURAL GAS:
Extension of natural gas service into the Millyard area could **provide the incentive for prospective tenants** to locate to Sanford. Currently, natural gas lines are located approximately 4.2 miles away from the Millyard at the Sanford Airport. The most logical route to extend service between the airport and the Millyard is along Route 109/ Main Street. Securing commitments to tie into the gas system from enough prospective customers currently located in Sanford would increase the feasibility that Unitil would construct the gas main as opposed to only constructing the main for the purposes of serving the Mills.

SEWER and DRAIN:
Sewer and storm water drain capacity in the Millyard is **adequately sized to accommodate** future development that would produce similar wastewater volumes to those seen when the all the Mills were in active use.

WATER:
Fire protection capacity of the Millyard is excellent.

ELECTRICAL:
Currently, the Millyard and the Riverwalk areas contain above ground electrical power lines. Upon speaking with Central Maine Power (CMP), there does not appear to be any upgrades to this area in the foreseeable future. Efforts should be made to **lower the power lines** into underground conduits on either end of the Riverwalk. A cost analysis to conduct this work is warranted.

ENVIRONMENTAL REMEDIATION

UNDERSTAND THE CHALLENGES TO CREATE SOLUTIONS
The Sanford Millyard has obvious remnants of its industrial past, from the mill buildings themselves to old boiler plants and the lone remaining smoke stack. What is less obvious are the contaminants that lurk within buildings and the landscape. Seven different parcels within the Millyard have been investigated through a Phase I Environmental Site Assessment (ESA). Four of these seven have been further analyzed through a Phase II ESA.

Sanford's textile production required a wide variety of chemical components that ranged from petroleum to solvents. Today's stormwater impacts continue the process of accretion of contaminants from roadway run-off. The site's past and present must be managed in order to mitigate the effects that these chemical compounds had and will continue to have on soil and groundwater. Further, there is evidence of groundwater impacts from upgradient off-site sources at some of the Millyard properties.

REMEDIATION OPTIONS:
The Remediation strategy for the Millyard is to systematically **contain, treat or remove the offending components within each parcel** to prepare them for renovation and redevelopment. Through community engagement, it was clear that public opinion is strongly in favor of a comprehensive clean up that includes a variety of remediation technologies. A collaborative approach will be needed to bridge the variety of mill building ownership, environmental, and potential redevelopment conditions across the Millyard. While the Town has been successful in securing both assessment and clean up money for many of their brownfields, there is still work to be done throughout the Millyard.

CREATING A BETTER ENVIRONMENT FOR ECONOMIC GROWTH:
Today's competitive real estate market offers indications that **start-up companies are looking for inexpensive and open loft spaces**, but these types of spaces - centrally located, affordable and in good condition - are hard to find. Should interior and exterior contaminants be mitigated and addressed, the Millyard provides an ideal venue to absorb some of this growing market demand.

RENEWABLE ENERGY

HARNESS THE SITE'S LATENT ENERGIES
The Sanford Millyard and the land adjacent to the Mousam River offer exciting opportunities to **harness, capture and store the site's natural energies**. Renewable energy technologies of today include: wind, solar, geothermal, bio-energy, hydropower, tidal/wave or ocean and hydro fuel cell. For the purposes of the Millyard, **geothermal and solar power** offer the most potential to decrease reliance on traditional fuel sources and to assist in the rebranding of the site from a contaminated place into a sustainable and environmentally-sensitive destination.

GEOTHERMAL: A Geothermal Heat Pump (GHP) system is a heating and cooling system that takes advantage of **heat stored in the ground**. The system uses the stability of underground temperatures to extract heat in the winter to warm spaces and cool building temperatures in the summer. A GHP system does not have aesthetic impacts; the infrastructure is below-grade and can be integrated with the landscape architecture of the site with minimal modifications. There are **no adverse environmental impacts** in a properly designed and installed GHP system.

SOLAR: Solar photovoltaic (PV) systems require unshaded or **open areas on roofs or on the ground**, preferably with southern exposure. Solar resources for Sanford are moderate, although most mill buildings have large, flat, south-facing rooftop surfaces which lend themselves well to solar arrays. There are also large areas adjacent to the Millyard where a solar array could be installed. The payback period of a solar application ranges from 16-26 years.

HYDROPOWER/WIND: The dam at the base of Number 1 Pond offers the most potential for capitalizing on water pressure as it flows towards the Millyard. However, due to extreme seasonal fluctuations of water volume, there are limitations as to how this power may be used. In addition, modest wind site speeds compromise the potential to harness power from the wind.

Sanford has already made a huge investment of public funds in downtown streets, sidewalks, utilities and other infra-structure. Capitalizing on the site's latent natural energies will provide a long term, cost-effective solution for diminish-ing the Millyard's reliance on fossil fuels.

ECONOMIC DEVELOPMENT

NEIGHBORHOOD STABILIZATION
The reuse of the Mill buildings will have significant and ongoing economic impact beyond the historic buildings themselves. The buildings and the legacy they represent can be the building blocks for new economic development. A commitment to reinvesting in the Millyard is also a commitment to the downtown, particularly the older residential neighborhoods nearby, the Midtown Mall site and Main Street. By focusing attention and policies to the Millyard, **Sanford is directing resources to those areas that need them most**. Resuscitating some of the dilapidated housing stock must become a priority if Sanford's neighborhoods are to thrive and support downtown businesses.

INCREMENTAL GROWTH
The rehabilitation and reuse of the Millyard will take a generation or more to become a destination in and of itself. One must look beyond traditional market analyses and seek out **a mix of place-specific, non-traditional uses** that can create vitality and reposition a property or district as an interesting destination. One must attract small tenants and projects at first that build upon one another. Over time, these initial uses can **build value and generate a more positive image** for the area that leads to new interest in the remaining unoccupied space.

MIX OF USES
There is nearly 1,000,000 square feet of vacant space. No single use will ever be able to utilize that much space or be a silver bullet. Even large institutional partners could only occupy a portion of the complex. Nevertheless, a common characteristic of most successful "white elephant" rehabilitation projects is that more than one use can be inserted into the development. Old mill buildings, with their large, open floor plans, lend themselves well to a wide range of possible uses and programs.

TRANSIT
The construction of the Sanford Transit Center (STC) adjacent to the Millyard is an added benefit for redevelopment. It will enable more people to access the area and create a multi-modal destination for pedestrians, bikes and buses. The proximity of the STC to the Mill complex will allow for greater connectivity and access.

ENGAGED COMMUNITY

COMMUNITY ASPIRATIONS
The Millyard is central to Sanford's sense of place. The Mill buildings are the most prominent feature of the landscape, visible to all who enter the town. Identifying opportunities to **reoccupy even a portion of the complex** will improve the region's self-esteem and people's attitudes towards old industrial buildings.

PARTNERSHIPS
Preserving the buildings presents a significant challenge; their massive scale and unmaintained condition make for a complex task. However, saving an endangered industrial heritage will be made easier by **engaging strong partners**. Broad, sustained efforts, combined with creativity, will help move the mill buildings off of the endangered list and on to **new roles in which they serve the community** in productive ways.

The Millyard was once a **concentration of employment op-portunities** and contributed to the economic vitality of the region. These opportunities can emerge again in the reoc-cupation of the site when partnerships are fostered with:

- Health and Wellness institutions;
- Educational partners;
- Sustainable product manufacturers;
- Arts and Culture organizations;
- Private developers.

COMMUNITY REVITALIZATION
Historic preservation is an effective small-town economic development strategy. More than ever, cultural and natural assets form the basis for economic development in small communities. The greatest attractions for economic growth in many towns are the **quality of life, natural environment, historic legacy and cultural context**. Preserving the charac-ter of the Millyard is vital to Sanford's economic competitive edge over other towns in the region and Northeast United States.

Community feedback to date highlights the desire to develop a **meaningful implementation plan** that will be a catalyst for future growth, preserve and reuse as much of the complex as possible, and focus on the remediation of the brownfields sites that are most likely to house new uses.

IMPROVED HEALTH

HEALTH AND WELLNESS
The design of the physical environment has a crucial and positive influence on improving public health. The redevelopment of the Sanford Millyard and surrounding open space network will create new opportunities for daily physical activity and represents a promising strategy for pursuing **environmental change** in Sanford's downtown.

THE LANDSCAPE
The Millyard is well positioned to advance health and wellness in the region in the following ways:
1. Through the **remediation of brownfield sites** into active and passive parkland;
2. Through the formulation of "**Number Two Pond**" and the associated Riverwalk;
3. Through connections to the broader **trail network**;
4. By **attracting tenants** that are associated with health and wellness and would benefit from the association.

The design of the trail network will promote physical activity and increase community awareness of the benefits of active living. The Riverwalk and Number Two Pond will increase opportunities for physical activity by extending the existing trail system that **enhances linkages with adjacent neighborhoods**. A more robust open space network can also influence the policies and partnerships that support active living in Sanford and York County.

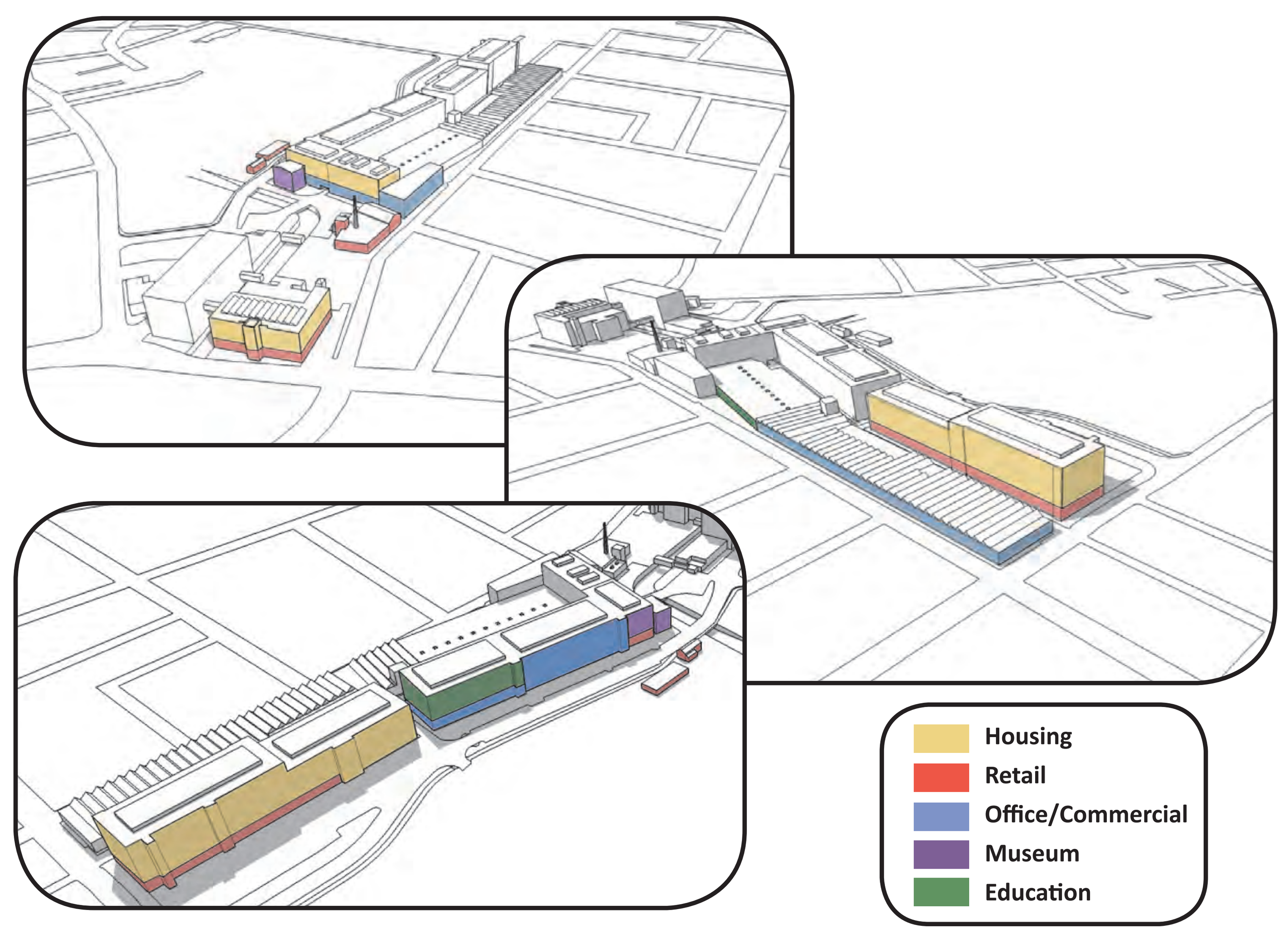
THE BUILDINGS
The reoccupation of the buildings themselves, in addition to remediation of the landscape, can also help to rebrand the site as a place of wellness. Repositioning the Millyard as place of health and wellness targets **specific niche tenants** that would not otherwise look to locate in Sanford. Organic food producers, recreation retailers and health-related partners can begin to build on the health and wellness concept and create synergies between them.

GOODALL PARTNERSHIP
A potential partner in this theme for the revitalization of the Millyard is Goodall Hospital. As the town's largest employer, there are partnering opportunities to collaborate with the region's primary health care facility. The hospital is less than a mile from the Millyard. Focusing on health, wellness and recreation align with the hospital's core mission.

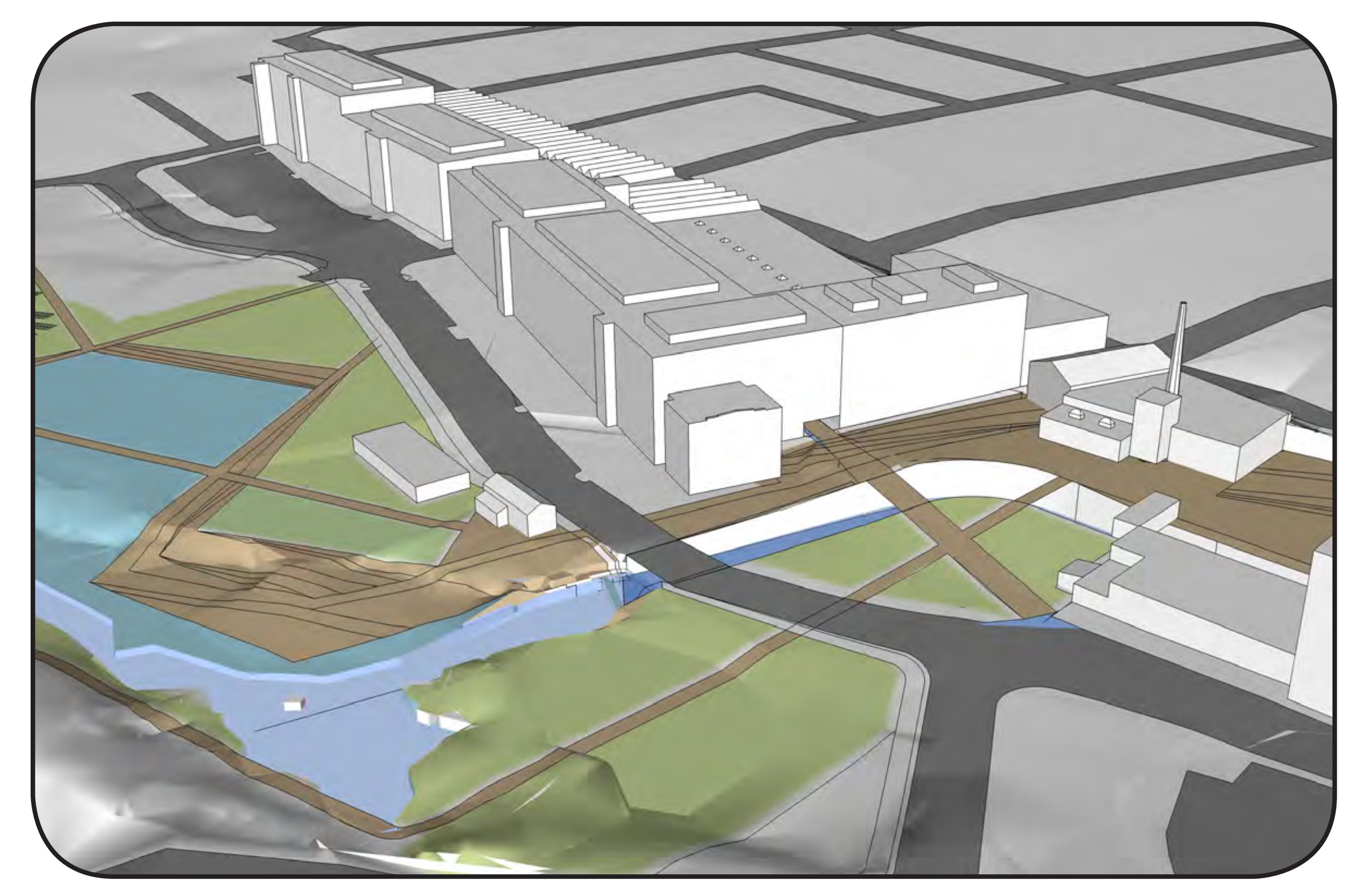
KEYS TO IMPLEMENTATION

MILLYARD REPOSITIONING
It is important to advance the Sustainability/Healthy Lifestyle "niche" and undertake a detailed redevelop-ment analysis of the Mill District properties under such a market niche strategy. Such an analysis will **deter-mine phasing, initial targeted property redevelop-ment and tenancy and future phases, development partnership options, tax credit analysis and public infrastructure needs**. This work will assess more fully initial occupancy and tenancy opportunities and ad-vance partnership options with both Mill owners and local institutional anchors.

NEXT STEPS
- Creation of a Town Bicycle/Pedestrian Advisory Board;
- Exploration of incentives for fresh food financing initiatives;
- Identification of necessary changes to the physical environment to make it more walkable such as the installation of countdown timers, high-visibility crosswalks and speed-limit signage;
- The development of new programs and/or events to promote active living such as a fitness fair, 5k run or sprint triathlon;
- Application for technical assistance for the National Park Service "Rivers, Trails and Conservation Assistance Program".



THE BUILDINGS



THE LANDSCAPE

NOTES/COMMENTS:

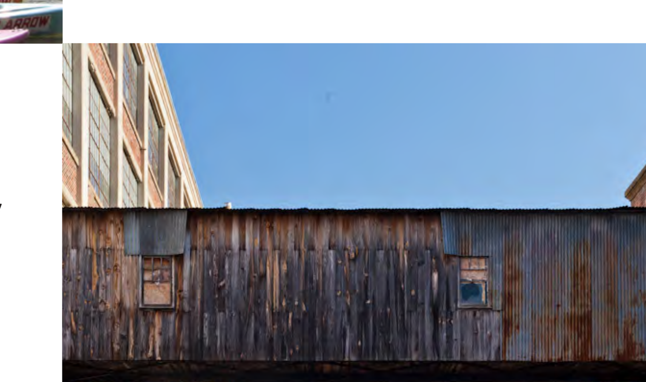
KEYS TO IMPLEMENTATION

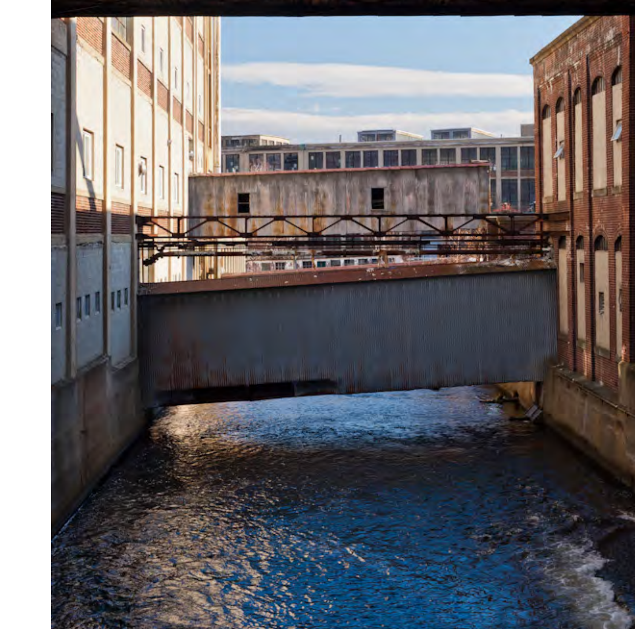
RENEWABLE ENERGY FEASIBILITY STUDY + DESIGN
Incorporating renewable energies are integral to the repositioning strategy of the Millyard. They will pro-vide valuable publicity, recognition, and reinforcement of the new focus for the community.

WATER RETENTION DESIGN AND INFRASTRUCTURE IMPROVEMENT TECHNICAL ANALYSES
Advance the introduction of a **Geothermal Heat Pump and Solar Photovoltaic System**. Conduct a detailed geotechnical and geological study of subsurface condi-tions for the implementation of a geothermal system. For a solar PV project, design the site layout, system size, electrical improvements, structural checks and secure the necessary permits.

Conduct necessary technical analysis for the creation of Number Two Pond (historically known as Watley Pond) and advance the site planning and design of the Mousam Riverwalk. Investigate the reintroduction of **hydro-power for a portion of the Millyard's energy needs.** Both can become integral elements of the redevelopment strategy, enhance the site's reputation and provide sustainable options for power generation and active living.

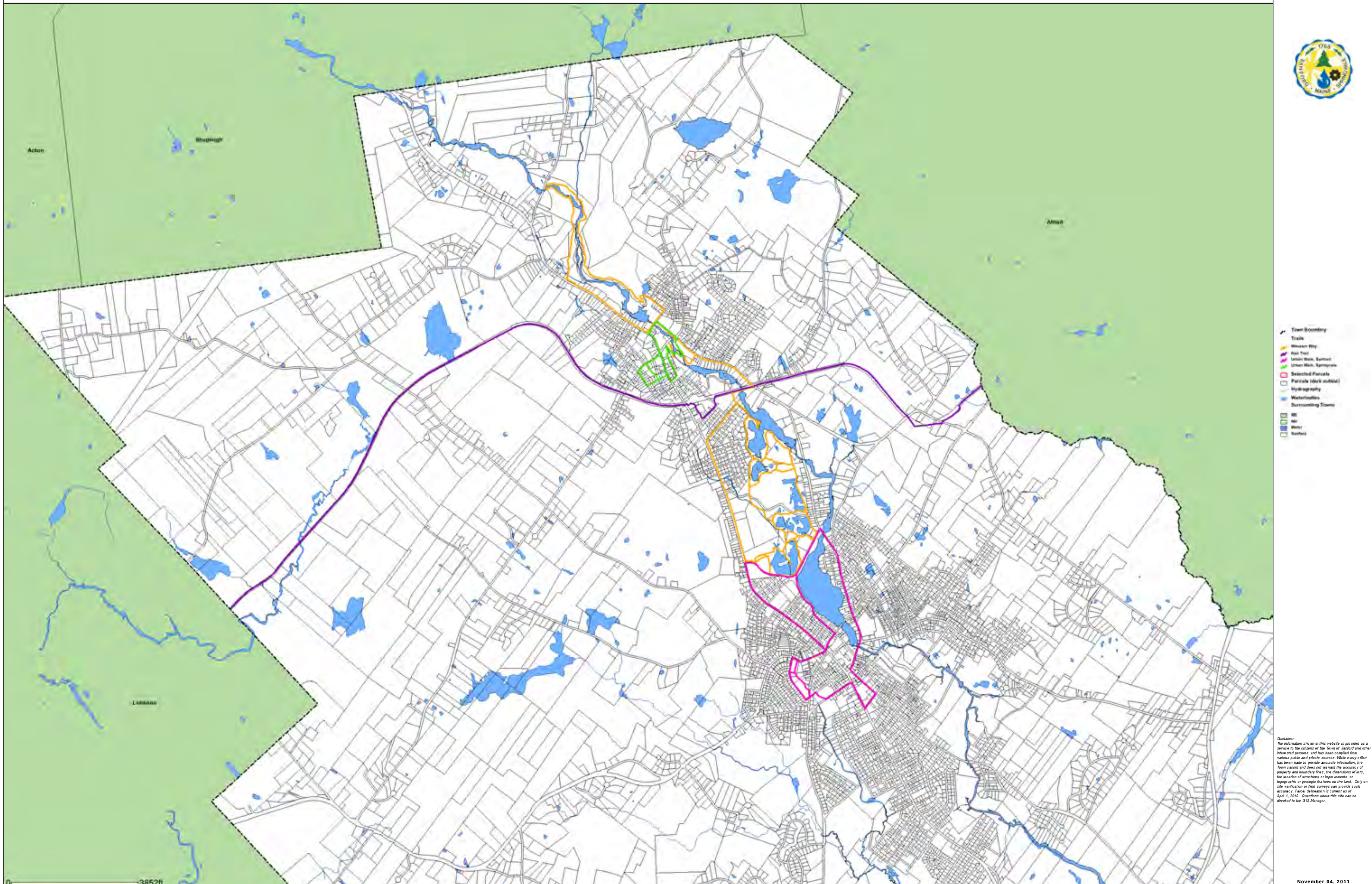
Coordinate with utility company for the removal of the overhead electric lines and installing them below ground along the proposed Riverwalk.





RETOOL REMEDIATE RENEW REDEVELOP REINVEST RECREATE

Sanford Area Map with Trails



Disclaimer
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November 04, 2011